



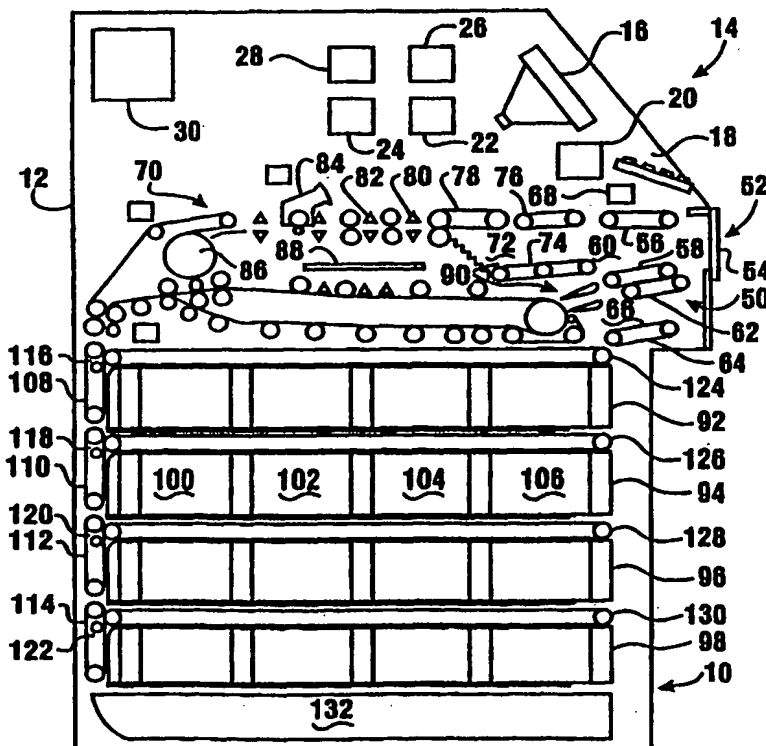
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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| (51) International Patent Classification <sup>6</sup> :<br><b>B65H 7/02</b>   |  | (11) International Publication Number:<br><b>WO 99/28225</b>   |
| <b>A1</b>   |  | (43) International Publication Date:<br>10 June 1999 (10.06.99)  |
| (21) International Application Number:<br><b>PCT/US98/24999</b>   |  | (81) Designated States: BR, CA, CN, MX, RU, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).. |
| (22) International Filing Date:<br>19 November 1998 (19.11.98)  |  |  |
| (30) Priority Data:<br>60/067,319      28 November 1997 (28.11.97)      US<br>09/193,775      17 November 1998 (17.11.98)      US   |  |  |
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(54) Title: DOCUMENT ALIGNMENT MECHANISM FOR CURRENCY RECYCLING AUTOMATED BANKING MACHINE

## (57) Abstract

Paper currency is oriented in skew and transverse alignment to accomplish deskewing and centering. The deskewing and centering device (84) includes a shuttle (204). The shuttle includes pinch wheels (212 and 214) and sensors (216, 218 and 220) that are positioned in the direction transverse to the path of the currency. The rotation of the pinch wheels is selectively controlled to orient the leading edges of the currency perpendicular to the path of the currency. After the currency is properly oriented it is released.



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**DOCUMENT ALIGNMENT MECHANISM FOR  
CURRENCY RECYCLING AUTOMATED BANKING MACHINE**

**TECHNICAL FIELD**

This invention relates to automated banking machines. Specifically  
5 this invention relates to an automated banking machine that enables currency  
bills, notes or other documents deposited by one customer to be identified and  
stored in the machine, and later selectively dispensed to another customer.

**BACKGROUND ART**

Automated banking machines are known in the prior art. Automatic  
10 banking machines are used to carry out transactions of value. A popular type  
of automated banking machine is an automated teller machine (ATM). Other  
types of automated banking machines are used to count and dispense cash.  
These machines are often used by tellers or customer service representatives in  
banking and other transaction environments. Other types of automated  
15 banking machines are used to make or receive payments, to dispense or  
receive tickets, travelers checks, scrip, cash or other documents or items of  
value, or to electronically check or transfer funds.

ATM machines commonly in use accept deposits from customers and  
process the deposits using devices which are separate from the devices which  
20 dispense currency and other items to customers. Most common ATM  
depositories require customers to place their deposits in an envelope. The  
envelope is accepted into the machine for storage. Although the customer  
indicates the value of the contents of the envelope, the customer's account is  
often not credited for the amount of deposit until the envelope is removed  
25 from the ATM by bank personnel and the contents verified.

Other ATM machines have the capability of receiving checks and other  
negotiable instruments. Such machines may include a device such as is shown  
in U.S. Patent Number 5,422,467. Devices of this type can be used to cancel  
and produce electronic images of checks which are deposited into an ATM

machine. The canceled checks are stored in the machine for later removal by bank personnel.

Currency notes, travelers checks and other documents and sheet materials that are commonly dispensed by ATMs, are generally housed in the machine in removable canisters. Sheets are dispensed from the canisters and delivered by the machine to customers. Periodically these canisters must be removed from the machine and the supply of sheets therein replenished. This is a labor intensive activity. To replace the canisters the secure portion of the ATM must be opened. The canisters in the machine must be removed and new canisters, which include a new supply of sheets, placed in the machine. Alternatively the canisters in the machine may be opened, money or other sheets added, and then replaced. After the canisters are replaced the secure portion of the machine must be closed.

The replacement or resupply of canisters often requires transporting filled canisters to the machine and returning partially depleted canisters to a remote location. While efforts have been made in the design of canisters to minimize opportunities for pilferage, there is always some risk. Therefore such activities are normally carried out by armed couriers. More than one person is often assigned to any task where there is access to the cash or other valuables in the machine. Because numerous individuals may be involved in loading replacement canisters, transporting replacement canisters to ATM machines, replacing the canisters, returning the removed canisters and auditing the contents of returned canisters, it is often difficult to identify the cause of any losses.

The need to periodically replace currency canisters is an inconvenience because the ATM must be shut down. Customers are not able to use the ATM while the supply of currency is being replenished, and lost opportunities to conduct transactions and customer dissatisfaction may result. Customers will also be disappointed if replenishment operations are not performed frequently enough and the machine runs out of currency or other documents.

Other types of automated banking machines, such as those that dispense cash to customer service representatives, have the same drawbacks as ATM machines. Periodic replenishment of the currency or other valuable documents that are dispensed by the machine must be done to keep the machine in operation. While such machines speed the cash dispensing service to the customer, there is a significant cost associated with segregating, preparing and transporting the currency before it is placed within the machine.

Other banking machines have been developed for identifying and counting currency. Such machines may be used in banking and vending environments. Machines which count currency generally require that the currency be pre-oriented a particular way to obtain proper identification. This is time consuming for the person operating the machine. Many currency counting machines also tend to reject valid notes due to natural deterioration which occurs in U.S. currency. The speed associated with such currency counting and accepting machines is also less than desirable in many cases.

Automated banking machines which are capable of receiving currency, identifying the particular type and denomination of currency, storing the currency and later dispensing it to a customer have been used in countries outside the United States. Such recycling machines are feasible in countries such as Japan where currency notes include special features which facilitate their identification by machines. However, such recycling machines have not generally been feasible with U.S. currency notes which generally do not include special features that facilitate identification by machine. U.S. currency notes also are subject to a wide range of conditions such as wear, soiling and bleaching which do not render a note unfit for use, but which render it very difficult for a machine to properly identify.

The currency recycling type banking machines that have been developed also generally suffer from slow operating speeds. This is particularly true when the machines are used to process a large number of notes. Often such machines require that the notes be oriented in a particular way and considerable time is associated with the rejection of notes due to

improper orientation. The handling of the sheets to facilitate identification and storage is also a time consuming process. Once a sheet has been initially identified as proper and stored in the machine, there is generally no check to be sure that the original determination of the type and character of the note was correct. As a result, a customer may receive a misidentified note. This can reduce customer satisfaction.

Thus there exists a need for a currency recycling automated banking machine that is more reliable, operates more quickly, and which can be used with U.S. and other currencies as well as other documents which have a wide range of properties.

#### DISCLOSURE OF INVENTION

It is an object of the present invention to provide a currency recycling automated banking machine.

It is a further object of the present invention to provide a currency recycling automated banking machine that is reliable and that operates more rapidly.

It is a further object of the present invention to provide a currency recycling automated banking machine that works with currency notes and other documents that have a wide variety of properties.

It is a further object of the present invention to provide a currency recycling automated banking machine that is capable of unstacking and separating documents input in a stack.

It is a further object of the present invention to provide an automated banking machine that orients documents relative to a sheet path while moving such documents at a high rate of speed.

It is a further object of the present invention to provide a currency recycling automated banking machine that can transport a plurality of documents in a sheet path concurrently and at a high rate of speed.

It is a further object of the present invention to provide a currency recycling automated banking machine that identifies documents and which returns unidentifiable documents to a customer.

It is a further object of the present invention to provide a currency recycling automated banking machine that enables a customer to deposit documents into the banking machine, and after the documents have been identified, to elect whether to deposit the documents or to have them returned.

5 It is a further object of the present invention to provide a currency recycling automated banking machine that can identify deposited documents regardless of orientation.

10 It is a further object of the present invention to provide a currency recycling automated banking machine that enables selectively storing deposited documents in storage areas in the machine.

It is a further object of the present invention to provide a currency recycling automated banking machine that enables selectively storing deposited documents in removable canisters.

15 It is a further object of the present invention to provide a currency recycling automated banking machine that enables recovery of documents stored in storage areas and dispensing the documents to customers.

20 It is a further object of the present invention to provide an automated banking machine in which documents may concurrently be transported, oriented, stored in storage areas and dispensed from other storage areas within the machine.

Further objects of the present invention will be made apparent in the following Best Modes for Carrying Out the Invention and the appended claims.

25 The foregoing objects are accomplished in a preferred embodiment of the present invention by a currency recycling automated banking machine. The machine has a document handling mechanism which includes an input/output area in which a customer may insert documents that are to be deposited and from which a customer withdrawing documents may receive documents.

30 A customer deposits documents in a stack through an opening in the housing of the machine. The documents are moved from the input/output area

into a central transport. In an unstack area documents are removed from the stack one by one by an unstack device and separated into a stream of single separate documents. The documents move along a document path in the central transport. The documents moving in the central transport are each  
5 deskewed by a deskew device to properly angularly orient them relative to the direction of travel along the document path. The documents are further moved by an alignment device to align them into a proper centered relation in the document path. The documents are further moved through a turnover device which turns the stream of documents while maintaining the angular and  
10 centered orientation thereof.

Each document is then moved past a document type identifier device . The identifier device operates to classify the documents as either identifiable which are acceptable to the machine, or unidentifiable or otherwise not acceptable. The identification device preferably operates to identify the type  
15 and/or denomination of each document. Identifiable acceptable documents are directed into an escrow area while unidentifiable or otherwise unacceptable documents are directed into a reject area of the input/output area of the machine.

A customer is informed of any unidentifiable documents through input  
20 and output devices on an interface of the machine. Any unidentifiable documents may then be delivered to the customer from the reject area. Alternatively, depending on the programming of the machine and/or inputs by the customer, such rejected documents may be stored in the machine for later analysis or routed through the central transport again past the identification  
25 device.

Properly identified documents are initially held in the escrow area. The output devices on the interface of the machine indicate indicia to the customer representative of the type and/or value of the identifiable documents. This type and value data is calculated by the control system of the machine.  
30 The customer preferably is enabled to select whether to have such documents returned or to deposit such documents. If the customer elects to have the



documents returned, the documents are passed out of the input/output area through the opening in the housing and the customer's account is not credited for the value of the documents.

5 If the customer elects to deposit the documents the documents are again moved through the central transport in a stream of rapidly moving separated documents. The documents are again identified by the identification device. However, rather than being routed to the reject and escrow areas, the identified documents are now preferably routed by the control system of the machine to selected storage areas. The storage areas are locations in which  
10 documents of the particular types are stored in the machine. The storage areas in the machine of the preferred embodiment are areas in a plurality of removable canisters. The control system of the machine operates to cause the customer's account to be credited for the value of the deposited documents.

15 The same customer who deposited documents or a subsequent customer wishing to make a withdrawal from the machine may receive documents that have been previously stored in the storage areas. Document dispensing mechanisms associated with the storage areas selectively remove documents from the storage areas responsive to the control system and route the documents to the central transport of the machine. As the documents  
20 move through the central transport they pass the identification device. The type and denomination of each document being dispensed is verified. This assures that the initial identification of the documents made when they were deposited in the machine is correct. This third verification reduces the risk that a customer withdrawing documents from the machine will be given an  
25 improper document. The documents are removed from the storage areas concurrently so as to facilitate rapid operation of the machine and are controlled in movement through the remote transport segments and the central transport to assure that they move as a stream of separated documents as they pass the identification device.

30 The identified documents to be dispensed to the customer are moved by the central transport to an escrow area. From the escrow area they are

presented to the customer through the opening in the housing of the machine. The control system of the machine operates to cause the customer's account to be charged or debited for the documents that have been withdrawn.

#### BRIEF DESCRIPTION OF DRAWINGS

5           Figure 1 is a schematic cross sectional view of currency recycling automated banking machine of a preferred embodiment of the present invention.

          Figure 2 is a schematic diagram of the functions performed by the machine shown in Figure 1.

10           Figure 3 is a cross sectional view of the components of the central transport and the input/output area of the machine.

          Figure 4 is a view similar to Figure 1 schematically representing input of a stack of documents by a customer.

15           Figure 5 is a schematic view of the input/output area shown receiving a stack of documents from a customer.

          Figure 6 is a view similar to Figure 5 showing the document stack after it has been placed inside the machine.

20           Figure 7 is a schematic view similar to Figure 1 showing an inserted document stack being moved from the input/output area of the machine to the document unstack area of the machine.

          Figure 8 is a schematic view showing the stack moving from the input/output area to the unstack area.

          Figure 9 is a schematic view of the unstack area of the machine prior to arrival of the stack.

25           Figure 10 is a schematic view of the unstack area showing a stack of documents being transported into the unstack area.

          Figure 11 is a view similar to Figure 10 showing the stack of documents moving into position for unstacking.

30           Figure 12 is a view similar to Figure 11 with the documents in position for unstacking in the unstack area.

Figure 13 is a view similar to Figure 1 showing documents passing from the unstack area through the central transport to the reject and escrow areas of the machine.

Figure 14 is a view similar to Figure 12 showing a document being  
5 unstacked in the unstack area.

Figure 15 is a view similar to Figure 14 showing a document being removed from the stack and moving past the sensors for sensing doubles and pre-centering.

Figure 16 is a schematic view showing a double note being retracted  
10 into the stack.

Figure 17 is a cross sectional view of a mechanism used for unstacking notes in the unstack area.

Figure 18 is a schematic view of a shuttle half which is part of a deskewing mechanism, the shuttle half being shown in a note passing position.

Figure 19 is a view similar to Figure 18 showing the shuttle half in a  
15 note stopping position.

Figure 20 is a top plan view of a shuttle used for deskewing and centering documents in the central transport.

Figure 21 is a schematic view of a skewed note.

Figure 22 is a schematic view similar to Figure 21 showing the note  
20 being deskewed by the operation of the shuttle.

Figure 23 is a view similar to Figure 22 showing the note aligned transversely to the direction of travel in the central transport but in an off center condition.

Figure 24 is a schematic view of the note shown in Figure 23 having  
25 been moved by the shuttle to a centered position in the central transport.

Figure 25 is a schematic view showing the shuttle moving a document transversely to the direction of travel in the central transport.

Figure 26 is a schematic view of the pre-centering and centering  
30 circuitry used in connection with a preferred embodiment of the present invention.

Figure 27 is a schematic view of the input/output area of the machine as documents are delivered from the central transport.

Figure 28 is a schematic view similar to Figure 1 showing unidentifiable documents being delivered out of the machine to a customer.

5 Figure 29 is a schematic view of the input/output area showing unidentifiable documents being moved out of the machine.

Figure 30 is a schematic view similar to Figure 29 showing unidentifiable documents being routed into the machine for storage.

10 Figure 31 is a schematic view similar to Figure 1 showing documents held in escrow being routed into the central transport for storage in the machine.

Figure 32 is a schematic view of the input/output area moving the documents held in the escrow area.

15 Figure 33 is a schematic view showing a portion of the drive mechanism for the drive belts in the input/output area.

Figure 34 is an isometric schematic view of the input/output area drive mechanism.

20 Figure 35 is a schematic view similar to Figure 1 showing documents that have been previously held in the escrow area being unstacked and passed through the central transport and into the machine for storage in storage areas of document storage canisters.

Figure 36 is a schematic view of a belt and carriage roll arrangement used for transporting documents in the central transport of the machine.

25 Figure 37 is a side view of a guide used in connection with the carriage transport rolls.

Figure 38 is a cross sectional side view of the carriage rolls, document belts and guides shown in supporting connection with a document.

30 Figure 39 is a side view of a gate mechanism used for routing documents moving in remote transport segments, with the gate mechanism shown in a position enabling a document to pass directly therethrough.

Figure 40 is a side view of the gate mechanism shown in Figure 39 in a condition passing a document from the remote transport segment to a canister transport.

Figure 41 is a view similar to Figure 39 with the gate mechanism shown passing a document from a canister transport into the remote transport segment.

Figure 42 is a view of the gate mechanism shown in Figure 39 in a condition that enables a document to pass from the canister transport into the remote transport segment, with the document moving in an opposed direction from that shown in Figure 41.

Figure 43 is a view of the gate mechanism shown in Figure 39 with a document passing from the remote transport segment into the canister transport with the document moving in an opposed direction from that shown in Figure 40.

Figure 44 is a schematic view of an arrangement of belts and pulleys adjacent to the gate mechanism shown in Figure 39.

Figure 45 is a schematic view of a sheet transport exemplifying the principles used for moving documents in the remote transport segments and in the canister transports.

Figure 46 is a cross sectional schematic view showing a document moving in a transport of the type shown in Figure 45.

Figure 47 is a top plan view of a lid covering a storage area within a recycling currency canister.

Figure 48 is a side cross sectional view of a storage area in a currency canister shown with a sheet moving towards the storage area.

Figure 49 is a view similar to Figure 48 showing the sheet partially accepted into the storage area.

Figure 50 is a front plan view of the feed wheels, take away wheels and thumper wheels adjacent to the storage area, with the sheet shown moving into the storage area as shown in Figure 49.

Figure 51 is a view similar to Figure 49 with the sheet moved into the storage area but positioned above the stack of documents held therein.

Figure 52 is a view similar to Figure 50 with the accepted sheet integrated into the stack.

5        Figure 53 is a view similar to Figure 52 with the newly accepted sheet held as part of the stack by fingers positioned adjacent to the storage area.

Figure 54 is a schematic view similar to Figure 1 showing the flow of sheets from a storage area to an escrow area in response to a document dispense request input by a user.

10       Figure 55 is a cross sectional view of a storage area including a stack of sheets therein from which one sheet is to be removed as part of a dispensing operation.

Figure 56 is a view similar to Figure 55 in which the fingers holding the stack of sheets in the storage area have been retracted to enable the sheets  
15       to engage the inner surface of the bin door.

Figure 57 is a view similar to Figure 56 in which the bin door is raised with the feed wheels and thumper wheels shown beginning to move so as to pick a sheet from the stack.

20       Figure 58 is a view similar to Figure 57 showing the feed and thumper wheels moved to a position in which a top sheet in the stack is being removed therefrom.

Figure 59 is a front view of the feed wheels, thumper wheels, stripper wheel and take away wheels in engagement with a sheet as it is being removed from the stack in the manner shown in Figure 58.

25       Figure 60 is a view similar to Figure 58 with the sheet shown having been removed from the storage area and being sensed by a doubles detector.

Figure 61 is a top plan view of the bin door overlying a storage area showing a sheet having been removed therefrom and moving towards a gate mechanism adjacent to the remote transport.

Figure 62 is a schematic view similar to Figure 1 showing a stack of sheets that have been dispensed from storage locations being delivered to a user of the machine.

Figure 63 is a schematic view of the architecture of the control system of a preferred embodiment of the machine.

Figures 64-68 are a simplified flow chart showing an exemplary transaction flow for a deposit transaction conducted at a currency recycling automated banking machine of the present invention.

Figures 69 and 70 are a simplified flow chart showing the transaction flow of a withdrawal transaction conducted at the machine.

#### BEST MODES FOR CARRYING OUT INVENTION

Referring now to the drawings and particularly to Figure 1 there is shown therein a currency recycling automated banking machine representing one embodiment of the present invention generally indicated 10. The machine includes a housing 12. Housing 12 includes a customer interface in an interface area generally indicated 14. Interface area 14 includes components used for communicating with a user of the machine. These components may include a display 16 which serves as part of an output device. The interface area may also include a keypad 18 and/or a card reader 20 which serve as portions of manually actuatable input devices through which a user may input information or instructions into the machine. It should be understood that these devices are exemplary and other input and output devices such as a touch screen displays, audio speakers, iris scan devices, fingerprint reading devices, microphones, voice recognition devices, user recognition devices, infrared transmitters and receivers and other devices which are capable of receiving or providing information may be used.

The machine also includes other devices which are indicated schematically. Such devices may include a receipt printer 22 which provides receipts to customers concerning activities related to their transactions. Other devices indicated schematically include a journal printer 24 for making a paper record of transactions. A passbook printer 26 indicated schematically may

also be included within the housing of the machine. A check imaging device 28 may also be included for purposes of producing electronic images of checks deposited into the machine as well as for canceling such checks. Such a check imaging device may be of the type shown in U.S. Patent Number 5,422,467 or other mechanism providing performing an imaging function.

Devices 22, 24, 26 and 28 are exemplary and other devices may also be included in the machine such as video cameras for connecting to a remote location, an envelope deposit accepting mechanism, ticket printing devices, devices for printing statements and other devices. It should further be understood that while the embodiment described herein is in the form of an automated teller machine (ATM) the present invention may be used in connection with other types of automated banking machines, which for purposes of this description includes any device or system which operates to electronically affect a transfer of value between two or more entities.

The machine 10 includes a control system generally indicated 30. The control system is in operative connection with the components of the machine and controls the operation thereof in accordance with programmed instructions. Control system 30 also provides for communications with other computers concerning transactions conducted at the machine. Such communications may be provided by any suitable means, such as through telephone lines, wireless radio link or through a connection through a proprietary transaction network.

The preferred embodiment of the invention has the capability of recycling currency or other sheets or documents representative of value received from a customer. For purposes of this description except where indicated, the words documents, sheets, notes and currency are used interchangeably to refer to the sheet materials processed by the invention. The process of recycling involves receiving the documents in bulk from a customer, identifying the type of documents deposited and storing the documents in appropriate locations within the machine. The stored documents



may then be selectively retrieved and provided to customers who wish to withdraw funds from the machine.

The preferred embodiment of the invention includes devices which comprise the functional components schematically indicated in Figure 2.

5 These functional components include an input/output function which receives documents from and delivers documents to users of the machine. An unstack function 34 receives documents from the input/output function 32. The unstack function serves to separate the documents from the stack and deliver them into a sheet path in separate, spaced relation.

10 The functional components of the machine further include a deskew function 36. As later discussed in detail, the deskew function operates to orient the documents so that they are properly transversely aligned with a sheet path. An alignment function 38 further orients the moving documents by centering them with regard to the sheet path. After the documents have been  
15 aligned they are passed to an identify function 40. The identify function operates to determine the type of document passing through the sheet path. In the preferred embodiment the identify function includes determining the type and denomination of a currency bill or other document. The identify function also preferably determines if a document appears suspect or is simply not  
20 identifiable.

The identify function is linked to the input/output function so that customers may have any suspect documents or identifiable documents returned to them, rather than be deposited in the machine. The identify function is also linked to document store and recover functions 42, 44, 46 and  
25 48. The store and recover functions operate to store documents in selected locations, and to recover those documents for purposes of dispensing the documents to a customer. For purposes of this discussion documents handled by the invention will be generally flat, rectangular sheet type documents with a front face, a back face and four side edges extending between the front and  
30 back face. However embodiments of the invention may handle other document configurations.

Referring again to Figure 1 the apparatus which performs the previously described functions is shown schematically. The input/output function is performed in an input/output area generally indicated 50. The input/output area is adjacent to an opening 52 in the housing of the machine.

5 Access through opening 52 is controlled by a movable gate 54 which is shown in the closed position in Figure 1.

Input/output area 50 includes a document handling mechanism with four belt type transports. These belt type transports are devices suitable for moving a stack of sheets, and preferably each comprise a plurality of belts  
10 such as is shown in U.S. Patent Number 5,507,481. The facing and opposed flights of first belts 56 and second belts 58 serve as stack supporting members and bound a delivery/reject area 60 which extends vertically between the belts. As later explained, belts 56 and 58 are movable vertically relative to one another and move transversely in coordinated relation to transport a stack of  
15 sheets positioned therebetween.

The document handling mechanism which includes input/output area 50 also includes third belts 62 and fourth belts 64. The facing and opposed flights of third belts 62 and fourth belts 64 vertically bound an escrow area generally indicated 66. Belts 62 and 64 are similar to belts 56 and 58 and are  
20 capable of moving a stack of documents transversely therebetween. The belts in the input/output area, as well as gate 54, as well as other components in the machine which move, are driven or moved by appropriate drives schematically indicated 68 which include appropriate motors and transmission mechanisms operatively connected to the various components and which are  
25 operated in response to the control system 30. The input/output area can be operated in various modes, examples of which will be discussed hereafter. Figure 3 shows the input/output area 50 in greater detail. It should be understood that while the document handling mechanism of the embodiment shown uses opposed belt flights as the document supporting surfaces, other  
30 embodiments of the invention may use combinations of other types of moving

or stationary surfaces as document supporting surfaces for selectively moving documents thereon.

5       The input/output area communicates with a central transport generally indicated 70. Central transport 70 includes an unstack area generally indicated 72. The unstack area includes a tray 74 which is suitable for moving a stack of documents thereon. Unstack area 72 further includes transport belts 76 and pick belts 78. As later explained in detail, the components in the unstack area operate as an unstack device to separate documents and deliver them in spaced relation into the document path of the central transport.

10       The deskew operation also includes doubles sensors 80 for use in detecting instances of double documents which have been removed from a stack in the unstack area. These documents can be separated in a manner later discussed. Pre-centering sensors are also provided in association with the unstack operation, which sensors operate to assure that the deskew and  
15       alignment operations can be performed properly.

      From the unstack area sheets are transported to a combined deskew and centering device 84. Deskew and centering device 84 includes a deskew device which functions to angularly align sheets transversely to a sheet path. It also includes an aligning device which functions to transversely move the  
20       sheets so that they are centered relative to the sheet path through the central transport.

      From the deskew and centering device, documents change direction by being turned on a turnover device which includes carriage rolls 86 and are moved past an identification device 88. Identification device 88 is preferably  
25       of the type shown in U.S. Patent Application Serial Number 08/749,260 filed November 15, 1996 which is owned by the Assignee of the present invention, and the disclosure of which is incorporated herein by reference. In alternative embodiments, other types of identification devices may be used. The identification devices preferably identify the type and character of passing  
30       note. The identification device also preferably distinguishes genuine documents such as genuine currency bills from unidentifiable or suspect

documents. In this way the identification device operates to classify the documents as those which are acceptable to the machine or unacceptable to the machine.

From the identification device, documents are routed selectively in response to the position of divert gates schematically indicated 90. The divert gates operate as part of a routing device. The divert gates move in response to drives which operate under the control of the control system to direct documents either to the delivery/reject area 60, the escrow area 66 or into the document storage and recovery areas of the machine.

The document storage and recovery areas include recycling canisters 92, 94, 96 and 98, which are later described in detail. The recycling canisters are preferably removable from the machine by authorized personnel. In the embodiment shown each of the recycling canisters include four storage areas therein. These are represented by storage areas 100, 102, 104 and 106 in canister 94. The storage areas provide locations for storing documents that have satisfactorily passed through the central transport. Documents are preferably stored in the storage areas with documents of the same type. Documents stored in the storage areas can later be removed or picked therefrom one at a time and delivered to other customers.

Documents are moved to the canisters through a remote transport which includes remote transport segments generally indicated 108, 110, 112 and 114. The remote transport segments are preferably arranged in aligned relation such that documents may be passed between the transport segments. Each remote transport segment has a media gate mechanism associated therewith. The media gates generally indicated 116, 118, 120 and 122 operate in a manner later explained to selectively direct documents from the remote transport segments into connection with adjacent canister delivery transports indicated 124, 126, 128 and 130. The canister transports operate in a manner later explained, to move documents to and from the storage areas in the canisters.

It should be appreciated that the various components which comprise the gates, transports and storage areas have associated motors and sensors, all of which are in operative connection with the control system 30 for purposes of sensing and controlling the movement of documents therethrough.

5 It should also be noted that in the preferred embodiment of the invention a dump area generally indicated 132 is provided within the housing of the machine at the bottom of the remote transport segments. Dump area 132 functions as a receptacle for documents that are determined not to be suitable for handling or which are otherwise deemed not suitable for later  
10 recovery and dispensing to a customer. In the preferred embodiment dump area 132 comprises a tray which can be moved outward on the housing of the machine to facilitate cleaning and removal of documents when the interior of the machine is accessed.

The operation of the currency recycling automated banking machine  
15 will now be explained through an example of the operative steps and functions carried out in connection with a deposit transaction by a customer. It should be understood that this is only an example of one manner in which the machine may be operated. Other methods of operation and functions may be achieved based on the programming of the machine.

20 The transaction flow for the deposit transaction is shown in Figures 64-68. A customer approaching the machine 10 operates the components in the customer interface area 14 to enable operation of the machine. This may include for example insertion of a credit or debit card and the input of a personal identification number (PIN). Of course other steps may be required  
25 by the customer to identify themselves to the machine. This may include other modes of operation such as finger print identification or biometric type devices. These steps which the customer goes through to identify themselves to the machine is represented in Figure 64 by the customer ID sequence which is indicated 134. The ID sequence is preferably operative to have the machine  
30 resolve an account of the user which is either debited or credited as a result of transactions carried out at the machine.

After the customer identifies themselves to the machine, the machine is programmed to proceed through the main transaction sequence generally indicated 136. This main transaction sequence preferably provides the customer with a menu of the various transaction options that are available to be conducted at the machine 10. The transaction flow proceeds in Figure 64 from a step 138 in which a customer chooses to conduct a deposit transaction which involves the input of documents, such as currency bills or notes.

When the customer indicates that they intend to make a deposit the machine next executes a step 140. In step 140 an inner gate indicated 142 in Figures 4 and 5 moves to block further access to the interior of the machine from delivery/reject area 60. After the inner gate 142 is extended, the program next executes a step 144 in which the front gate 54 on the machine is moved to uncover opening 52. These sensors are photo sensors in the embodiment shown, but may be other types of presence sensors in other embodiments. In this position a customer is enabled to insert a stack of documents indicated 146 in Figure 5 into the delivery/reject area 60 between belts 58 and 56. As shown in Figure 5, belts 58 and 56 may also be run inwardly to help to position the stack 146 against the inner gate 142.

As shown in Figure 6, delivery/receipt sensors 148, 150 are positioned inside the housing of the machine adjacent to opening 52. In the transaction flow, as shown in Figure 64, a step 152 is executed to determine if the deposit stack 146 has been moved past the sensors. A determination is made at a step 154 as to whether the sensors are clear. If sensors 148 and 150 are not clear, a step 154 is carried out. In step 154 efforts are made to clear the sensors. This is done by running the transport belts 56 and 58 inward at a step 156 and prompting the customer at step 158 to input their deposit. A check is then made again to see if the sensors have cleared. Provisions are made in the transaction flow so that after a number of tries to clear the sensors, the transport belts 56 and 58 are run in reverse to remove anything that has been input into the machine, and the gate 54 is closed.

If however the sensors 148 and 150 are clear indicating that a stack of documents has been properly inserted, the transaction flow moves to a step 160 in which the front gate 54 is again closed as shown in Figure 6. The transaction flow then moves on to a step 162 in which the inner gate 142 is retracted so that the stack 146 can be further processed in the manner hereafter described.

The stack is next moved as schematically shown in Figure 7 from the delivery/reject area 60 to the unstack area 72. This is accomplished as shown in Figure 65 by moving a carriage which supports fourth belts 64 upwards in the input/output area 50 as shown in Figure 8. The carriage for belts 64 is moved upward by a drive including a motor and transmission mechanism to engage a carriage supporting belts 62 and 58 and to move it upward as well. The carriages move upward until stack 146 is sandwiched between belts 56 and 58. This is represented by step 164 in Figure 65. Belts 58 and 56 are then driven to move the stack inwardly toward the unstack area 72.

The unstack area 72 which includes the components which comprise the unstack device, is shown in greater detail in Figure 9. It includes transport belts 76 and pick belts 78, which are independently operable by motors and/or other suitable driving devices. A strip back stop 166 is movably positioned in the area between transport belts 76 and belts 168 on tray 74. It should be understood that belts 76, 78 and 168 are arranged to be in intermediate relation when the tray 74 is moved adjacent thereto in a manner described in U.S. Patent Number 5,507,481 the disclosure of which is incorporated herein by reference.

Unstack area 72 includes an unstack wall 170. Unstack wall 170 includes a plurality of steps 172 thereon, the purpose of which is later explained. The steps include in cross section step surfaces that extend generally perpendicular to one another. Unstack wall 170 includes therein a plurality of generally vertically extending slots (not shown). Tray 74 includes a plurality of tray projections 174 which extend from an upper surface of the tray and extend into the slots. Adjacent to pick belt 78 are contact stripper

wheels indicated 176 and non-contact stripper wheels 178, the function of which is later explained.

In operation of the machine the stack 146 is moved into the unstack area for unstacking. This is represented by a step 180 in Figure 65. As shown in Figure 10, in the step of moving the stack 146 into the unstack area, the tray 74 is moved sufficiently away from the transport belts 76 by a moving mechanism so that stack 146 may be moved therebetween. The backstop 166 is raised by a moving mechanism to allow entry of the stack. Transport belts 76 and tray belts 168 move forward so that stack 146 moves towards unstack wall 170. In the preferred form of the invention tray 74 is spring biased upwards and once stack 146 is moved therebetween the stack is held between belts 168 on tray 74 and transport belts 76 and pick belts 78 by the biasing force acting on the tray. The moving mechanisms for the backstop, belts and trays are drives which include suitable motors and transmission devices.

As shown in Figure 11, once the stack 146 moves past the backstop 166, the backstop is lowered by its moving mechanism to be in position behind the stack. As later discussed, the backstop is particularly useful when stripping double notes which may be picked during the unstack operation. As shown in Figure 11 belts 78 are further run in the forward direction to move stack 146 towards wall 170. As shown in Figure 12 when the stack is fully moved against the wall 170, the angled wall and the steps 172 on the wall surface tend to splay the sheets in the stack. This splaying of the sheets tends to break the surface tension between the adjacent sheets and facilitates the separation of each adjacent sheet from one another. It should be noted that the steps 172 are configured in a progression with the angle of the wall with step surfaces bounding the steps extending generally upward and step surfaces extending in a direction of sheet travel. The steps are configured such that engagement of the sheets in the stack 146 with the steps 172 generally does not interfere with the movement of tray 74 upward as sheets are removed from the stack. This enables tray 74 to apply a continuous upward biasing force such that the upper most sheet in the stack engages pick belts 78.



Referring again to the transaction flow in Figure 65, once the stack has been moved to the unstack position a check is made at a step 182 to verify the presence of bills in the unstack area. Assuming that bills are properly in position the flow then moves to an unstack routine at a step 184. As later explained in detail, the control system 30 of the present invention is a novel type control system which facilitates the rapid operation of the machine. As represented by phantom step 186 the control system operates to perform tasks concurrently. As a result, rather than unstacking a single note in the manner hereafter described and then waiting for it to be processed, the preferred embodiment of the control system 30 unstacks a note and as soon as that note has left the unstack area, proceeds to unstack another note. This enables providing a stream of separated sheets which are concurrently moving in the central transport under control of the control system. This greatly speeds the operation of the machine.

The operation of the machine in the unstack operation is schematically represented in Figure 13. As shown therein, the stack 146 in the unstack area 72 is separated into a stream of single sheets which are moved through the central transport 70 in the direction of Arrows C. The notes are then selectively directed for reasons later explained by a routing mechanism which includes divert gates 90 into either the delivery/reject area 60 or the escrow area 66.

The operation of the unstack device to unstack sheets in the unstack area 72 is explained with reference to Figures 14-17. The stack 146 is biased upwards against the pick belts 78 by the tray 74. The lower flight of belts 78, which serve as picking members is engaged with the top sheet in the stack, is moved towards the left in Figure 14 to pick a sheet 188. As shown in Figure 17 the pick belts 78 are supported on rollers and the faces of the pick belts which engage the sheet extend beyond the faces at the outer circumference of non-contact stripper wheels 178. Contact stripper wheels 176 are arranged in generally abutting relation opposite the inner two strip belts 78. As the strip belts move to the left, as shown in Figure 14, the contact stripper wheels and

non-contact stripper wheels 176 and 178 do not move, thus moving in an opposed direction relative to the moving pick belts. This serves to engage a back face of the top sheet which is moved from the stack and serves to keep sheets other than the top sheet in the stack.

5           It should be noted that the configuration of the rolls supporting the strip belts 78 and stripper wheels 176, 178 give sheets a wave or scalloped cross section as shown in sheet 188, as the sheet is picked from the stack. This deformation of the sheet helps to facilitate separation of the sheet from the stack. While belts and rolls are used in the preferred embodiment to impart a  
10           wave configuration to the sheets, in other embodiments other combinations of rollers, tracks, projections, fingers, guides and belts may be used to deform and/or move the sheets.

          Referring again to Figure 14, if the sheet 188 that is moved from the stack is a single sheet, this condition is sensed by the doubles sensors 80. This  
15           means that the sheet is suitable for movement in the central transport. The sheet is then moved past the doubles sensors 80 into the vicinity of take away rolls 190, 192. In response to the sheet being sensed as a single sheet, take away roll 192 is moved responsive to the control system from the position shown in phantom to the position shown in solid lines in which wherein it is in  
20           engagement with the sheet 188. The take away rolls 192, 190 are driven in the directions indicated to move the sheet away from the stack. The driving of the take away rolls is timed by the control system 30 to assure that sheet 188 is properly spaced a distance from the proceeding unstacked sheet moving through the central transport.

25           As shown in Figure 15 sheet 188 is moved by take away rolls 190 and 192 which serve as a take away device, past pre-centering sensors 82. The pre-centering sensors operate in a manner later described to sense the position of the transversely opposed pair of side edges of the sheet. These edges generally bound the sheet and extend parallel to the direction of sheet  
30           movement. The signals from the pre-centering sensors 82 are used by the control system 30 to move a shuttle which serves as a sheet catching device

and which is associated with deskewing and centering operations for the sheet. The control system is operative to move the shuttle transversely in the transport path to a position in which it is enabled to catch the moving sheet in the manner that will enable the sheet to be aligned. Preferably the shuttle is  
5 moved by the control system to catch each document in generally centered relation between the side edge surfaces of each note. This feature is particularly valuable when the sheets which are removed from the stack are of different sizes.

It should be understood that while the U.S. has currency notes which  
10 are the same size for all denominations, other countries use different sized documents for various currency types. It is a fundamental advantage of the present invention that the documents inserted by a user need not be arranged so that the documents are all of the same size, nor do the documents need to be oriented in any particular direction in order to be handled by the preferred  
15 embodiment of the invention. The unstacking device of the described embodiment is particularly well adapted to unstacking the sheets having various sizes and which may not necessarily be positioned so as to have a side edge in alignment with the wall 170, particularly for the sheets in the middle of the stack 146.

In the event that a double bill or document is sensed by doubles sensors  
20 80, the bills can be separated. A double bill is indicated in Figure 16 by sheets 194 which for purposes of this example, are considered to be two overlapped sheets. To separate these sheets pick belts 78 are stopped and tray 74 is moved downward responsive to the control system so that the stack 146 is no longer  
25 biased against the lower flights of pick belts 78.

Pick belts 78 are then run backwards such that the lower flight thereof is moved to the right as shown. This pulls sheets 194 back into the stack. The contact stripper wheels 176 and the non-contact stripper wheels also rotate to facilitate pulling the sheets back into the stack. This is accomplished in the  
30 preferred embodiment by having the stripper wheels operated by a one way clutch. The stripper wheels may rotate freely in the direction shown in Figure

16, but may not rotate in the opposed direction. The movement of belts 78 pulls the sheets 194 back into the stack. The strip backstop operates to prevent the sheets from moving too far and falling out of the stack.

5       Once the sheets 194 are returned to the top of the stack the tray 74 is again raised and a picking operation is attempted. Generally one or more repeated attempts to strip the sheets will be successful such that sheets are continuously removed from the stack 146 one by one. It should be understood that while belts are used as the picking member and rolls are used as stripper members in the embodiment described, in other embodiments other types of  
10       members may be used.

      The transaction flow associated with the sensing of doubles and efforts to strip the top sheet are represented in Figure 65. In a step 196 a determination is made as to whether a double (or higher multiple document) has been sensed during the unstack routine. If so, the step associated with  
15       lowering the stack 198 is executed. The pick belts are moved in reverse in a step 200 to pull the doubles back into the stack and the stack is then raised at a step 202. As previously discussed, the unstack routine is then started again. Of course if doubles are not sensed when a sheet is picked, the sheet moves past the pre-centering sensors 82 and the transverse position of the note in the  
20       transport is sensed at a step 204.

      After a document passes the pre-centering sensors, it then moves to the combined deskew and aligning device 84. The deskew device is adapted to catch a moving sheet and align its leading edge generally transversely to the  
25       direction of travel of the sheet in the sheet path. Once the leading edge of the sheet has been angularly aligned, the alignment device operates to move the sheet so that its center line is generally in alignment with the transverse center line of the transport path. Doing this enables the document to be more rapidly identified for reasons which are later explained.

      As shown in Figure 20 the combined deskew and alignment device 84  
30       includes a shuttle indicated 204. The shuttle is comprised of a pair of shuttle halves 206 and 208. Each shuttle half includes a sheet brake for slowing an

area of the sheet which the sheet brake engages. Each shuttle half is connected to a drive shaft 210. The drive shaft is rotated by a drive motor or similar device which operates to move pinch wheels 212 and 214 on the shuttle halves in the manner hereafter explained. The shuttle 204 is also movable transversely in supporting connection with drive shaft 210. The shuttle is moved by a transverse moving device which operates responsive to a motor or similar drive device which is operatively connected to the control system of the machine. The shuttle also includes a first sensor 216 adjacent to shuttle half 206 and a second sensor 218 adjacent to shuttle half 208. The shuttle also includes a middle sensor 220. In one embodiment the sensors are optical sensors, but other sensors may be used. The pinch rolls engage a segmented idler shaft 222. The idler shaft includes transversely adjacent segments which are independently rotatable.

Referring to Figure 18, shuttle half 206 is schematically shown therein. The shuttle half includes a solenoid 224. Solenoid 224 is connected to a movable brake rod 226 which is movable on pins 228. The solenoid and brake rod are part of a brake mechanism. The pinch wheel 212 serves as a movable member and revolves around a center pin 230. The center pin 230 is movably mounted in a slot 232 on the body of the shuttle half 206.

The drive shaft 210 is a splined type shaft as shown. The shaft 210 extends through a drive wheel 234 which is mounted for rotation on the body of the shuttle half 206. The drive shaft and drive wheel serves as a part of a first drive mechanism for moving the pinch wheel 212.

As shown in Figure 18 when the solenoid 224 is not energized the pinch wheel 212 is biased into engagement with the drive wheel 234 by a spring schematically indicated 236. The pinch wheel 212 rotates in response to rotation of the drive shaft 210. The rotation of the pinch wheel 212 also engages the independently rotatable segments of the segmented shaft 222. Documents are enabled to pass through the nip between pinch wheels 212 and the segmented shaft 222 in response to rotation of pinch roll 212 by the drive wheel 234.

As shown in Figure 19, when the solenoid 224 is energized the brake rod 226 moves. The brake rod serves as part of an engaging device for engaging the pinch wheel so as to discharge from the drive wheel. As a result the pinch wheel slows rapidly. The movement of the brake rod causes the brake rod to engage pinch wheel 212. As the brake rod engages the pinch wheel, the pinch wheel is displaced from the drive wheel 234. The pinch wheel is held stopped by engagement with the brake rod and is prevented from moving until the solenoid is again de-energized and the brake rod is retracted. As a result, the area of the document that is positioned in the nip between pinch roll 212 and segmented shaft 222 when the solenoid is energized, will be stopped in this position. The documents is prevented from moving in the area of the nip until the solenoid is de-energized.

The operation of the shuttle is schematically indicated in Figures 21-24. As shown in Figure 21 a sheet or document 238 is shown moving in the direction of the arrow in the sheet path. The shuttle is moved prior to arrival of the sheet in a transverse direction on the drive shaft 210 so that pinch rolls 212 and 214 will both engage the sheet. This is done by the control system 30 based on the signals from the pre-centering sensors 82 which are upstream of the shuttle 204. The precentering sensors are operative to sense the side edges at the transverse extremes of the sheet. The shuttle is moved transversely in the sheet path by the transverse moving device which includes a fast acting motor or other suitable device. The shuttle moves transversely to engage the sheet with both pinch rolls and such that the sheet is generally transversely centered between the pinch rolls.

In response to the sheet 238 moving into the area adjacent to the pinch rolls, the sensors 216, 218 and 220 sense the sheet. Because the sample sheet 238 is skewed, the sensor adjacent to pinch roll 214 which is sensor 218, will sense the leading edge of the sheet first. When this occurs, the solenoid associated with the shuttle half 208 energizes, stopping movement of pinch roll 214, while roll 212 continues to rotate in response to rotation of shaft 210. As a result, sheet 238 begins to rotate about the area of the pinch point 240

created between the stationary roll 214 and segmented shaft 222. Because sheet 238 moves such that the front and back faces of the sheet are held in the area of roll 214, the leading edge 242 of the sheet begins to angularly move into an aligned condition in a direction transverse to the direction of sheet movement.

As shown in Figure 23, sheet 238 rotates about pinch point 240 until leading edge 242 is transversely aligned with the sheet path. When an aligned condition is reached, the solenoid 224 is preferably energized to stop movement of pinch roll 212. This produces a second pinch point 244 between the note 238 and the idler shaft 222.

In the stopped condition of the note shown in Figure 23, the leading edge 242 of the sheet extends in the sheet path beyond centering sensors, generally indicated 246. The centering sensors are operative to sense the side edges of the sheet indicated 248 and 250 in Figure 23, in a manner hereinafter described. Upon sensing the side edges the control system 30 determines the position of a center line which extends through a center portion of the sheet 238. This center line is indicated schematically in Figure 23 as 252. The shuttle then moves the sheet transversely in the manner indicated in Figure 25. The sheet is moved in engaged relation between the pinch rolls 212 and 214 and the segmented idler shaft 222. As shown in Figure 24, sheet 238 is moved to the right such that the sheet center line 252 is generally in alignment with a center line of the sheet transport path 254.

Once the sheet has been deskewed in this manner and has been moved into a centered relation in the transport path, the solenoids operating the pinch rolls 212 and 214 are released simultaneously to discharge the sheet 238 from the shuttle. This is done responsive to the control system in the manner which assures that sheet 238 is properly spaced at least a selected minimum amount from a preceding sheet. Optimally the sheet is not delayed any longer than is absolutely necessary to assure that the sheet is properly oriented.

The schematic view of the components of the centering circuit which is part of the control system of the machine and which is used in connection with

the centering sensors 246 and the pre-centering sensors 82 is schematically indicated in Figure 26. In the preferred embodiment of the invention the sensors 246 include charged coupled devices (CCDs) which are used for sensing edges of the sheet. A sensor is included on each transverse side of the sheet path. An emitter is provided on an opposed sheet side. The emitter provides a radiation source for sensing the edges of the sheet. In other embodiments other types of sensors may be used. Signals from the sensors 246 are transmitted to an amplifier 256. Signals from the amplifier are forwarded to a digitizing comparator 258. The digitizing comparator is provided with a threshold input from an interface 260.

A trip point output from the interface 260 is determined by a software routine that adjusts the threshold input for the presence of a note based on the radiation received by the sensors when no note is present. This enables adjusting the sensors for changes during the operation of the device, such as changes in the intensity of the emitters or accumulation of dirt on the emitters or sensors.

The output from the digitizing comparator is transmitted to a programmable logic device 262. The programmable logic device determines the position of the edge of the note and transmits output signals along with timer signals to a processor 264. The processor generates signals in accordance with its programming to move the transverse moving device which moves the shuttle transversely to the desired position. In the case of the pre-centering sensors, the shuttle is moved to a position to ensure that it encounters the note preferably so that the note is generally centered between the pinch wheels. In the case of the centering and deskew operation sensors the shuttle is moved to assure that the note is moved to align it with the center of the transport. The timing signals also track when the leading and trailing edges of the note encounter the sensors to enable the control system to maintain proper separation of the notes within the central transport. The signals from the sensors 246, as well as those from sensors 216, 218 and 220



on the shuttle, are used to assure that a note which has been released from the shuttle moves away in the proper coordinated fashion.

The logic flow associated with the deskew and alignment operations of the described embodiment is shown with reference to the steps shown in Figure 65. As indicated by a step 266, the signals from the pre-center sensors 82 are used by the control system to move the shuttle to assure that it engages the note. A deskewing step 268 operates in the manner already described to align a leading edge of the note so that it extends transversely to the direction of sheet movement in the transport. At a step 270 the center line of the sheet is moved into alignment with the center line of the sheet transport. The sheet having been deskewed and aligned, it is released at a step 272 in a timed manner and continues on its way in the sheet path.

It should be understood that while in the described embodiment of the invention a pair of transversely disposed sheet brake mechanisms are used in the sheet path to engage and stop the sheet, in other embodiments of the invention the sheet brake mechanisms may have different relative speeds but not stop the sheet. Alternative embodiments may actually speed the rate of movement of an area of the sheet to orient it. However it should be understood that for purposes of this disclosure slowing an area of a sheet is relative to another area of the sheet, and would include increasing the speed of travel of another sheet area. It should be further understood that while in the described embodiment the sheet brakes include a movable member with both imparts motion and slows the sheets, in other embodiments sheet motion may be imparted by mechanisms other than those which relatively slow one area of the sheet compared to another area of the sheet so as to change its alignment.

As shown in Figure 13, after a document leaves the deskew and alignment device the document moves through the area of the central transport where it is sensed by various sensors associated with the identification device 88. In one preferred form of the invention the identification device includes the device described in U.S. Patent Application Serial Number 08/749,260 filed November 15, 1996 which is incorporated herein by reference as if fully

rewritten herein. This identification device is suitable for identifying the type and denomination of a passing document. It also is suitable for distinguishing genuine documents from suspect documents. An advantage of the device used in the described embodiment is its ability to identify a document despite the failure of the document to be in alignment with the sheet path. It should be understood that because of variable conditions, despite efforts made to orient each sheet, sheets may still be somewhat out of alignment at the time of analysis by the identification device. Of course in other embodiments, other devices for classifying and identifying sheets may be used.

The analysis of the note by the identification device 88 produces signals. These signals may be indicative of the note type and denomination. Alternatively, the signals may be indicative that the note cannot be satisfactorily identified or are invalid. These signals are transmitted to the control system 30 which operates the divert gates 90 adjacent to the central transport. As shown in Figure 27, in a preferred embodiment of the invention, documents which cannot be identified with a high degree of confidence or which are otherwise classified as unacceptable by the machine are routed by gates 90 to the delivery/reject area 60 and are supported on second belts 58 of the document handling mechanism. Such rejected notes are represented in Figure 27 by a stack 274.

Identified documents suitable for deposit are routed by divert gate 90 into the escrow area 66 where such notes are supported on belts 64. Such identified documents are represented in Figure 27 by stack 276. It should be understood that the routing of identified sheets to the escrow position 266 is optional depending on the programming of the control system 30 of the machine or customer inputs to the interface of the machine. Notes classified as acceptable and identifiable may be directly routed to appropriate storage areas for recovery.

The transaction flow associated with the analysis of the documents and routing to the reject/delivery and escrow areas of the document handling mechanism is represented in Figure 66. The analysis of the moving

documents is represented by a step 278. If the note is properly identified as a type that is acceptable in a step 280, a check is next made at a step 282 to determine if the machine is in a deposit mode. If so properly identified notes are routed to storage areas in the recycling canisters. If the machine is not currently in a deposit mode, which is the case with the example described, properly identified notes are routed to the escrow position in a step 284.

If in step 280 a note is not identifiable or is identified as unacceptable the note is routed to the reject position in a step 286. Of course it should be understood that the unstacking, pre-centering, deskewing, aligning and note identifying steps are all ongoing concurrently as each document in the stream of documents passes through the central transport. The notes are continuously being directed to the escrow or reject positions until the stack of notes has been completely unstacked.

In the operation of the invention of the preferred embodiment, sheets that are not acceptable to the machine, such as unidentifiable sheets, and sheets which appear suspect, are returned to the customer from the input/output area 50. This is schematically represented in Figure 28 which shows the reject stack 274 being delivered to the customer through the opening 52. This is normally done by the machine after displaying to the customer, through the interface 14, information on a number of documents which were unidentifiable or unacceptable in the deposit stack that they submitted. The control system may also calculate a value of the acceptable documents and the customer would be advised through the interface of the value of the documents that have been properly identified.

In alternative embodiments the customer may be given the option to input a retry input to an input device of the customer interface, which causes the machine to retry the rejected sheets to determine if they can be identified. If this occurs, the machine may be programmed to run the reject stack 274 back through the central transport in the manner previously done with the deposited stack. In the retry of the unacceptable documents only the documents in the reject stack may be rechecked or alternatively all the input

documents may be rechecked depending on customer inputs to the interface and/or the programming of the machine . If only the initially rejected documents are rechecked and any are determined to be acceptable the control system will recalculate the number and/or value of the acceptable documents.

5 The customer may be given various outputs and options for inputs depending on situations which arise. There are many options for the programming of the machine encompassed by the invention and the particular approach selected depends on the preferences of the operator of the machine.

10 Assuming that the reject stack 274 is to be returned to the customer, the reject stack is delivered to the customer in the manner indicated in Figure 29. The inner gate 142 is extended while the carriage supporting belts 64 are raised so that stack 276 engages the carriage supporting belts 62 and 58. Belts 58 are raised such that the reject stack engages belts 56. As reject stack 274 is sandwiched between belts 56 and 58 the gate 54 is opened. The reject stack  
15 274 is moved by belts 56 and 58 out through opening 52 in the housing of the machine. The delivery and receipt sensors 148, 150 adjacent to opening 52 are operative to sense movement of the stack.

The transaction flow associated with the delivery of the reject stack to the customer is represented in Figure 66. In a step 288, a determination is  
20 made as to whether notes are present in a reject stack after all the sheets have been unstacked and passed through the central transport. If so, the reject stack is moved to the delivery position in step 290. The inner gate is closed in a step 292, as shown in Figure 29. The front gate is then opened at a step 294 and the belts are driven to deliver the reject stack to the customer at a step 296.

25 As shown in Figure 67, the customer may then be prompted to take the reject stack at a step 298. This is done through the output devices on customer interface. The sensors 148 and 150 are then monitored at a step 300 and a decision is made at a step 302 as to whether the reject sheets have been taken. If the sheets have been taken the front gate 54 of the machine is closed at a  
30 step 304 and the inner gate is retracted at a step 306.

As previously discussed, in the described embodiment of the invention the customer is required to take the reject sheets. Therefore if at step 302 the customer has not taken the sheets, the transport is operated to push the sheets out the opening 52 in a step 308. After the transport has been run sufficiently to push the sheets out, the front gate is closed.

In alternative embodiments of the invention the customer may have the option of having the reject stack retried to determine if the documents can be identified. This is done in response to a customer input through an input device of the interface. In other alternative embodiments the machine may be programmed not to return unidentifiable or rejected sheets to the customer. This may be done for purposes such as to prevent potentially counterfeit sheets from being placed back in circulation. If the machine is programmed in this manner the reject stack 274 may be moved in the manner shown in Figure 30 back into the unstack area of the machine for a further pass through the central transport. In this second pass the sheets may either be again returned to the reject area if they cannot be identified; placed in the escrow area if they may be identified; or alternatively, passed into a storage location in the recycling canisters or dump area 132 for later analysis. Because the preferred embodiment of the present invention is capable of tracking individual sheets which are passed through the machine, it is possible for the machine to track where particular sheets originated based on their storage location and position within a storage location. This is done by storing information in a memory associated with the control system.

Returning to the operation of the described embodiment, the stack 276 held in the escrow position is now moved upward in the input/output area as indicated in Figure 31. At this point the customer may have the option of receiving the identifiable sheets that they have deposited back. This may be done for example if the customer does not agree with the count of the sheets by the machine. This may be accomplished by programming the machine so that the customer can obtain return of the documents in escrow by an appropriate input to an input device of the interface.

If the machine is programmed to deposit the identified documents held in escrow, the machine moves the document stack 276 in a manner shown in Figure 31. Alternatively, the escrow stack will be moved in the manner shown in Figure 31 if the machine requires a customer input to deposit the escrow documents and such an input is given through the customer interface.

When the escrow stack 276 is to be deposited in storage locations in the machine, belt 64 is raised to the position shown in Figure 32 and the escrow stack 276 is sandwiched between belts 62 and 64. The belts are then driven to move the escrow stack 276 into the unstack area of the machine in the manner previously described.

The operation of the document handling device which includes drive rolls and movable belt carriages of the input/output area 50 are described in greater detail in Figures 33 and 34. The carriage associated with belts 64 is moved upward and downward by a driving or elevator mechanism. The carriage supporting belts 62 and 58 is free floating but is restricted in the degree to which it may move downward. The carriage supporting the belts 56 may rotatably conform to the position of an adjacent stack but is generally prevented from moving downward from the position shown. This configuration minimizes the complexity of the document handling device.

In one preferred embodiment of the invention, the carriage supporting belts 64, 62 and 68 are guided to move vertically by a first guide/drive shaft 310 and a second guide/drive shaft 312. The guide/drive shafts serve as guides and the carriages move in operatively supporting connection therewith. The guide/drive shafts not only extend generally vertically, but also are splined shafts that are rotatable by suitable drive and transmission mechanisms in the directions shown. For example the drive may include one or more electric motors, which are operatively connected to the guide/drive shafts by gears, belts or other motion transmission devices. Movable journal guide blocks 314 and 316 are movable vertically on shaft 310. Each journal guide block represented by guide block 314 in Figure 33 includes bevel gears 318. The bevel gears operate to transmit rotational motion from the guide/drive shaft

310 to shafts 320 and 322. Shafts 320, 322 include rollers upon which belts 56 and 58 are supported respectively.

Journal guide blocks 324 and 326 are movable on shaft 312. As indicated in Figure 33 by journal guide block 324, the journal guide block includes bevel gears 328 which operate to transmit rotational motion of the drive/guide shaft 312 to shafts 330 and 332. Belts 62 and 64 are supported on rolls which are driven by shafts 330 and 332 respectively.

As should be appreciated, this arrangement for driving the belts in the input/output area reduces complexity compared to other arrangements. This arrangement also increases flexibility for selectively positioning stacks of documents. The belts of the embodiment shown are preferably arranged such that the opposed facing belt flights which bound the areas where stacks are accepted are transversely offset. This facilitates movement of the stacks without skewing. It also enables the document handling device to move the opposed facing belt flights adjacent and beyond the point where the opposed facing flights bounding an area are coplanar. This enable the adjacent carriages of mechanism to retract to a relatively small size in the vertical direction. This feature may be desirable when the carriages move adjacent without documents in an area between the opposed belts. It also facilitates moving the escrow area sufficiently upward to be in alignment with the unstack device or the opening in the housing. This enables a single housing opening of relatively small size to be used for receipt and delivery of documents. Of course, in other embodiments multiple openings may be used.

In the embodiment shown the stack supporting members include belt flights and all the belt flights are movable in a transverse direction to move the stacks of documents. In other embodiments other stack supporting members may be used. For example, arrangements of rollers, belts or other movable supporting members may be used to move stacks of documents. Arrangements of alternate or opposed moving and non-moving supporting members may be used. Alternatively, non-transversely moving supporting

members may be used with devices and supporting members which push or pull the stack.

Returning to the sample transaction flow with the escrow stack 276 in the position shown in Figure 31, the transaction flow proceeds in the manner indicated in Figure 67. As indicated in a step 334, the escrow stack is moved upwards so that it is generally aligned with the opening in the housing and in a position to either be delivered to the customer or to be moved back into the unstack position. The customer operating the machine is then prompted at a step 336 to indicate whether they wish to have the escrow stack returned to them or to deposit the amount in the escrow stack into the machine. As indicated by a step 338, if the customer chooses to have the stack returned rather than deposited, the machine proceeds to return the stack to the customer through the opening.

The process of returning the stack is indicated through the transaction flow represented in Figure 68. At this point in the transaction flow the escrow stack 276 is adjacent to opening 52, and may be readily delivered to the customer. The inner gate is closed at a step 340 and the front gate is opened at a step 342. Belts 62 and 64 are then driven to move the escrow stack outward to present it to the customer at a step 344. A determination is made at a step 346 whether the customer has taken the stack. This is based on signals from the sensors 148 and 150. If the escrow stack is sensed as taken the machine returns to the main ATM transaction sequence at a step 348.

If the customer does not take the stack, steps are executed to encourage the customer to take the stack, or to retract it into the machine. If the stack is not sensed as taken in step 346, the customer is prompted through the interface of the machine at a step 350 to take the stack. If the stack is now sensed as taken, a step 352 returns the machine to the main sequence. If however the stack is still not taken, the transaction flow proceeds through steps 354 and 356 in which the stack is recovered and stored, and an irregular transaction is noted. This may occur for example by retracting the stack into the machine,



closing the gate, and then passing the stack through the central transport to one of the storage areas.

Alternative forms of the invention may provide for crediting the customer's account for amounts which they indicated they wished to have returned but did not take. If the machine is programmed to operate in this manner the documents in the escrow stack will be stored according to their type and denomination in the various storage areas in the recycling canisters. In this case the control system operates to credit the customer's account for a deposit. This may be done by the control system updating account data stored in memory at the machine and/or by exchanging transaction messages with a remote computer system which tracks debit or credit card transactions.

Alternatively, the retracted documents in the escrow stack may be stored separately in one of the storage areas. The machine may be programmed to allow the customer to return at a later time and obtain the documents in the escrow stack. This may be valuable for example if the customer forgets to take the stack or is distracted while performing their transaction. The memory of the machine or other connected transaction systems may store a record of the incomplete transaction. The next time the customer accesses the machine they may be notified of the fact that they had an incomplete transaction. The interface may be used to notify the customer of the incomplete transaction and prompts them concerning completion, reversal or other options relating to the transaction. The user may then input instructions to complete or otherwise close the transaction. This feature may limit the customer's options for completing the transaction to the particular machine where the incomplete transaction occurred. Alternatively, when the record of the incomplete transaction is stored in the memory of a transaction system which is connectable to many machines, the customer may be allowed to complete the transaction at a different machine.

In most cases when a customer has deposited documents in the machine, they will choose to have the funds credited to their account. As a result, in the transaction flow at step 338 they will indicate through the

customer interface that they wish to make a deposit. The transaction flow moves through a step 358 in which the machine is set to deposit mode. Thereafter the escrow stack 276 is moved to the unstack area at a step 360. This is done in the manner previously described for the deposited stack.

5           As shown schematically in Figure 35, the escrow stack will now be unstacked in the manner previously discussed. However, now instead of the unstacked bills being routed by the divert gate 90 to the escrow area and delivery/reject area, the bills are selectively routed downward to another area in the machine as shown, to the various storage areas in the recycling  
10           canisters. During this operation each of the unstacked bills is again classified and identified by the bill identification apparatus 88. The identification of the bill type is used to selectively route each document to the storage area where documents of that type are stored. It should also be understood that the memory connected to the control system of the machine is preferably  
15           programmed to record the type of document held in the escrow stack and to compare the document type determination made in the initial pass to the type determination made in the second pass. In the event of an error or inconsistency, the divert gate 90 may be used to route any irregular documents to the delivery/reject area 60 instead of moving them down into a storage  
20           location in the machine, or moving them into another selected storage location.

          As can be appreciated with the transaction flow beginning at step 358 in Figure 67, the escrow stack undergoes the unstacking process previously described in connection with steps 184, 196 and 204. Each note is also deskewed and centered with regard to the transport path and then released.

25           The note undergoes analysis in the manner discussed in connection with step 278 and if the note is properly identified in step 280, the transaction flow moves to a step 262 when the machine is in the deposit mode. In step 262 each note is dispatched to an appropriate storage location. Notes are moved through this central transport in the direction of Arrows "D" shown in  
30           Figure 35. Each note is then routed to an appropriate storage location at a step 264. It should be appreciated that notes are moving concurrently toward

different storage locations under the control of the control system. Figure 35 shows an example of a note being deposited in storage area 102. It should be understood however that notes may be moved into numerous storage areas during the deposit process.

5           The notes in the stack 276 continue to be unstacked until the stack is determined to be depleted at a step 266. Assuming that no notes have been rejected during the deposit process, the transaction flow may then return to the main ATM transaction sequence at a step 268. The control system operates to modify the information in memory and/or to communicate messages with a  
10       remote debit or credit card processing system to credit the customer's account for the deposit. The customer may be provided with a receipt for their deposit and may continue with other transactions.

          In the operation of the central transport 70 there are places in which moving notes must undergo generally 180 degree turns. One example of this  
15       is indicated by transport section 370 which is shown in Figure 35 which includes a turnover device. In transport section 370, documents that have been aligned in the transport path have their direction reversed so that they can be passed adjacent to the identification device 88. Transport section 370 requires that the bills be transported accurately and maintain their spaced aligned  
20       relation. The documents are also preferably not crumpled or otherwise distorted, as this may adversely impact their ability to be identified in the following section. More details regarding transport section 370 are shown in Figures 36-38.

          The turnover device in transport section 370 includes a plurality of  
25       belts 372. These belts in the preferred embodiment are V-type belts that engage driving and idling rolls 374, 376 and 378. In the preferred form of the invention the "V" cross section of belts 372 is pointed radially inward as the belt passes rolls 374, 376 and 378.

          As belts 372 move between rolls 374 and 376 they are supported on  
30       carriage rolls 380. The carriage rolls 380 support the belt in a manner such that the "V" section is pointed away from the carriage rolls. A flat top surface

of each belt is positioned adjacent to an annular dimple 382 on the outer circumference of each carriage roll. Carriage rolls 380 are also spaced from one another. Guides 384 which generally have a somewhat lesser diameter than the carriage rolls are positioned in between. An example of a guide 384  
5 is shown in greater detail in Figure 37.

When a note 386 passes through transport section 370 it is held between the flat surfaces of belt 372 and dimples 382 of the carriage rolls as shown in Figure 38. The notes move around the carriage rolls without being skewed or distorted. When the notes are passed to the area adjacent to roll 376  
10 projections 388 on the guides urge the note away from engagement with the carriage rolls and in the desired direction.

This configuration is used in a preferred embodiment of the invention as it has been found that notes may generally be transported through the transport section 370 without adversely impacting their aligned and separated  
15 relation. The ability to turn the note path 180 degrees also greatly reduces the overall size of the automated banking machine.

As shown in Figure 35 notes which are passed through the central transport 70, and which are moved to storage areas within the machine, pass downward through the central transport through remote transport segments  
20 108, 110, 112 and 114. These remote transport segments operate as part of a remote transport. The remote transport segments are vertically aligned in the preferred embodiment so as to enable documents to be selectively transported between the transport segments. The transport segments also enable  
documents to be selectively directed either through the transport segments or  
25 into or out of the adjacent canister transports, one of which is positioned adjacent to each transport segment. The selective directing of documents is achieved through use of a media gate associated with each transport segment which is operated under the control of the control system 30.

An example of a transport segment used in a preferred embodiment of  
30 the invention is indicated by transport segment 110 shown in Figure 39. Transport segment 110 includes a plurality of spaced belt supporting rolls 390,

392. The rolls are driven by a drive in operative connection with the control system. Each of the rolls support a belt 394 thereon (see Figure 44). An inner flight 396 of each belt 394 extends generally in a first plane and is positioned adjacent to a first sheet supporting surface 398 and a second sheet supporting surface 400. The sheet supporting surfaces each include a plurality of spaced raised projections or dimples thereon. These raised projections serve to break surface tension and minimize the risk of documents sticking thereon.

The principles of operation of transport segment 110 as well as the canister transport used in the preferred embodiment, can be appreciated with reference to Figures 45 and 46. The transports operate by holding documents in engaged relation between an outer surface of a belt flight and elongated projections which extend toward the belt flight from an opposed adjacent supporting surface. In the example shown in Figure 45, belt flights 402 extend adjacent to an opposed supporting surface 404. Projections 406 extend transversely between the belt flights from the supporting surface. A document 408 which is engaged between the belt flights and the supporting surface is biased and deformed by the projections 406 to remain engaged with the belt flights. As a result, documents move with the belt flights. This enables movement of the belt flights to accurately move the document 408 in engaged relation therewith.

Returning to Figure 39, projections 410 extend from first sheet supporting surface 398. Projections 410 are generally segmented projections and include tapered leading and trailing edges to minimize the risk of documents snagging thereon. Idler rolls 412 and 416 are also journaled on and in supporting connection with the member which includes sheet supporting surface 398. Idler rolls 412 and 416 serve as movable members and are generally positioned in aligned relation with inner flights 396 and perform a function which is later explained.

Each remote transport segment has a canister transport adjacent thereto which meets the transport segment at an intersection. In the case of transport segment 110, canister transport 126 extends adjacent thereto as shown in

Figure 1. Canister transport 126 include pairs of spaced belt supporting rolls 418, only one of which is shown in Figure 39. rolls 418 are driven by a drive in operative connection with the control system. Rolls 418 support belts 420 which include lower flights 422. Lower flights 422 extend generally in a plane and further extend adjacent to a supporting surface 424 which includes dimpled projections thereon of the type previously discussed. Projections 426 extend from supporting surface 424 between the belts and are generally parallel thereto. This structure enables documents to be transported in engaged relation between the projections 426 and the belt flights 422 in the manner previously described. A transition surface 423 provides a smooth transition between supporting surface 398 and supporting surface 424 through the intersection which is generally indicated 421.

As shown in Figure 44 the rolls 418 of the canister transports and rolls 390 of the remote transport segments are arranged in transversely intermediate relation, similar to the manner in which the projections on the supporting surface are positioned transversely intermediate of the belt flights. This assures that documents can be passed between the transport segments in controlled relation in the manner hereinafter described. Rolls 418 extend through the plane of the first transport segment so as to impart a wave configuration to documents moved between rolls 390 and rolls 418.

Each of the remote transport segments includes a media gate which is selectively operable to direct documents in desired directions. A media gate is positioned at an intersection of each canister transport with the remote transport. In the case of transport segment 110 the media gate associated therewith is gate 118. Gate 118 includes a plurality of movable arms 428. The arms are engaged to move together by a drive in operative connection with the control system and are selectively movable about an axis of rolls 390. Each arm 428 has a roll 430 movably mounted thereon. Each roll 430 which serves as a diverter member, is positioned in alignment with a corresponding inner belt flight 396.

The operation of the remote transport segment and media gate will now be explained with reference to Figures 39-43. As shown in Figure 39, when the diverter roll 430 of the gate 118 is disposed from the belt flights 396, a document 432 is enabled to pass along a first direction directly through the remote transport segment. Although the document 432 is shown as moving upward in Figure 39, it should be understood that documents may be moved downward as well responsive to the drive and the control system moving rolls 390 and 392 in a selected rotational direction. Likewise documents may be moved downward and then upward in the remote transport segment.

Figure 40 shows a document 434 moving in a downward direction while the diverter roll 430 of the gate 118 is extended. In this condition the diverter roll extends in both the plane of the sheet path of the remote transport segment and the plane of sheet movement of the canister transport. The document 434 is directed toward the nip created by belt flights 422 and projections 426 of the canister transport 126. As a result, moving the belt flights 420 in the direction shown with the associated drive as the media gate is actuated transfers the document into a canister transport path along which it is carried by the canister transport. As can be appreciated from Figure 40, when the gate 118 is actuated and moved to the position to direct documents to and from the canister transport, belt flight 396 is deformed. Idler roll 416 supports the belt flight in the deformed position to prevent excessive wear as a result of friction.

Figure 41 shows a document 436 being moved from the canister transport to the remote transport segment 110. In the position shown the media gate 118 operates to direct document 436 towards the remote transport segment 108 positioned above remote transport section 110 (see Figure 35) and towards the central transport.

Figure 42 shows the gate 118 in a condition that directs a document 438 from the canister transport 126 downward into the remote transport segment 110. As will be appreciated from the foregoing discussion, the preferred embodiment of the invention enables moving documents from one

storage area to another. This function is enabled by the control system of the machine moving documents from storage areas in canisters where they have been stored to storage areas in canisters either above or below the storage canister in the machine.

5           Figure 43 shows a document 440 moving upward in the remote transport segment 110 and being directed by the gate 118 into the canister transport 126. The ability to move the documents in the manner shown in Figures 39-43 in response to the control system greatly facilitates the ability of the preferred embodiment of the present invention to store and recover  
10 documents. As will be appreciated from the foregoing Figures, the gate mechanisms may also be used to selectively orient documents. This may be desirable, particularly when it is desired to provide customers with documents uniformly oriented in a stack. This may be accomplished by re-orienting the documents prior to storage based on the orientation of each document as  
15 determined by the identification device 88. However as discussed previously, the embodiment of the present invention shown does not require documents to be oriented in any particular way for satisfactory operation.

The storage of documents in a storage location is now described with reference to Figures 47-53. For purposes of this illustration, storage of a  
20 document in storage area 102, as shown in Figure 35, will be discussed. However it should be understood that the following description is generally applicable to the storage of documents in any of the storage areas available in the machine of the preferred embodiment.

Referring to Figure 47, storage area 102 is shown from the top. Belt  
25 flights 422 of the canister transport 26 extend in a transport path above a bin door 442. Bin door 442 is movably mounted in supporting connection with the canister above storage area 102. Bin door 442 includes a supporting surface 444 which supports notes or other documents moving thereon to and from adjacent storage areas. Supporting surface 444 includes dimpled  
30 projections which serve to reduce surface tension and sticking of documents that move thereon.



Bin door 442 includes outward extending projections 446 which are transversely adjacent and generally parallel to the belt flights. The projections engage passing documents and maintain the documents in engagement with belts 422. A pair of apertures or openings 448 are in generally aligned relation with projections 446. Openings 448 provide access for thumper wheels which are later discussed and which serve as sheet engaging members. As can be seen in Figure 47 projections 446 are tapered adjacent to openings 448 to minimize the risk of documents sticking thereon. Bin door 442 also includes a plurality of idler rollers 450. Rollers 450 are positioned in aligned relation with belts 422. Rollers 450 engage the belts and facilitate movement of the belts when the bin door 442 is opened to accept a document in a manner that is later described.

Bin door 442 also includes a central aperture or opening 452. Opening 452 is sized to accept a pair of closely spaced thumper wheels 454 therein. The central thumper wheels 454 are similar in construction to outboard thumper wheels 456 which extend through openings 448. Central opening 452 is also sized to accept feed wheels 458 and 460 which serve as sheet engaging members and which are positioned adjacent to the front of the bin door 442 covering storage area 102. The feed wheels 458 and 460 are connected to thumper wheels 454 by a feed belt 462 which serves as a feed member.

It should be understood that thumper wheels 454 and 456, as well as feed wheels 458 and 460, are supported on a surface positioned adjacent to and vertically above bin door 442. The feed wheels and thumper wheels are preferably supported on the housing of the machine, whereas storage area 102 and bin door 442 are supported on recycling canister 94. The recycling canister may be removed from the machine when the feed wheels and the thumper wheels are positioned so they do not extend through opening 452.

Bin door 442 also includes a sensor 464 which serves as a sheet thickness detector. Sensor 464 in one form of the invention is an optical receiver type sensor that receives signals from an opto-emitter device which is positioned in the machine adjacent to and above sensor 454 when the canister

94 is in its operative position. Sensor 464 is in connection with the control circuitry of the machine. In other embodiments other types of detectors such as contact or non-contact detectors may be used.

5 The steps involved in storing a note in storage area 102 is now described with reference to Figures 48-53. Storage area 102 holds a stack 466 including a plurality of sheets, notes or other documents. Stack 466 is preferably a plurality of horizontally oriented documents which are supported on a push plate 468. Push plate 468 is biased upwards toward the bin door by a spring schematically indicated 467, or other biasing mechanism. The stack  
10 is held at its upper end by a plurality of transversely spaced front fingers 470 and back fingers 472 which engage the top sheet bounding the stack adjacent to the bin door. The front fingers and back fingers are movable by a mechanism in the manner hereinafter discussed. The mechanism includes a drive including linear or rotational motor type device and suitable transmission  
15 mechanism in operative connection with the control system.

Bin door 442 includes an inner surface 474 which includes a plurality of downward extending projections with recesses therebetween. In the position of fingers 470 and 472, inward facing projections 476, 478 adjacent the upper ends of the fingers 470 and 472 respectively, extend above the stack  
20 and are movable in the recesses of the inner surface of the bin door. These inward extending projections 476 and 478 of fingers 470 and 472 hold the top of the stack in captured relation in the positions shown in Figure 48.

In Figure 48 a document 480 is shown as it moves toward the storage area 402. In this position prior to arrival of the document, the feed wheels and thumper wheels are positioned above the supporting surface 444 of the bin  
25 door. Take away wheels 482 which are movably mounted on the canister 94 which includes storage area 102, are moved by a drive or other moving mechanism in operative connection with the control system to a position disposed away from the feed wheels 458 and 460.

30 Upon arrival of the document 480 at the storage area 102 the bin door 442 which is rotationally mounted to the canister at the rear thereof rises

upward in a front area adjacent to a front surface thereof. The take away rolls 482 move upward by the mechanism while the feed wheels 458 and 460 which are rotated by a drive engage and move the document into the storage area 102. Fingers 470 and 472 also hold and move the upper surface of the stack downward relative to the door against the biasing force which is applied upward by the push plate 468. This enables document 480 to move into the storage area above the inward projections of the fingers.

Figure 50 shows the configuration of the feed wheels and take away wheels as document 480 is moved into the storage area. In this condition the rotating feed wheels 458 and 460 engage document 480 as do the take away wheels 482, so that the document may be driven into the storage area. As shown in Figure 50 a stripper roll 484, the operation of which is later discussed in detail, remains disposed away from the feed belt 462 as the document 480 enters the storage area.

As shown in Figure 51 document 480 enters the storage area 102 above the stack 466. Fingers 470 and 472 are then moved outwardly as shown in Figure 51. This is done by a mechanism which operatively interconnects the fingers and moves them together in coordinated relation responsive to signals from the control system.

As shown in Figure 52, eventually fingers 470 and 472 are moved outwardly a sufficient distance to release the stack 466 so it moves upwardly in response to the biasing force on the push plate 468. As a result, document 480 is integrated into the stack as the bin door 442 is moved downward to its original position by its associated moving mechanism. When the bin door is moved downwardly the inward extending projections on the fingers 472 and 470 are in aligned relation with the recesses on the inside surface of the bin door, and the fingers extend therein.

From the positions shown in Figure 52, fingers 470 and 472 are moved inwardly by the finger moving mechanism to again capture the top surface of the stack which now includes document 480. The take away wheels 482 are again retracted downward by operation of the mechanism associated

therewith and storage area 102 is again ready to receive further documents for storage therein.

As will be appreciated from the foregoing discussion, mechanisms such as those shown and discussed are used to move the bin door fingers ,  
5 wheels and other devices responsive to the control system. These mechanisms may include rotational or linear motors and other mechanisms, transmissions and linkages suitable for use in moving the components in the manner described. Such components are referred to in the drawings as drives 68 to promote clarity and facilitate understanding of the operation of the invention.

10 Any device or mechanism suitable for achieving motion of the type shown or described for the components may be used in embodiments of the invention.

It should be understood that when one or more documents are routed into a storage location in the machine, the storage location where the particular document(s) are to be stored undergoes the described series of steps. While  
15 the series of operations for the storage location has been described as receiving documents and then integrating them into the stack in the storage location one document at a time, it should be understood that the mechanisms in the storage areas may optimally be configured so that a plurality of documents may be collected in the storage area above the fingers and then the fingers and bin  
20 door moved to integrate the plurality of documents into the stack. Such a configuration may be used to optimize the speed of operation of the automated banking machine. It should be further understood that while the mechanism for storing documents in the storage areas is exemplary, other mechanisms which store such documents may be used in alternative embodiments of the  
25 invention. Such mechanisms may include specifically devices which include only one or other numbers and configurations of movable members for holding and releasing the stack of documents in the storage location.

The operation of machine 10 is now described with regard to a transaction in which documents are retrieved from storage areas in the  
30 machine and dispensed to a customer or other operator of the banking machine. This is represented schematically in Figure 54. In a dispensing

operation, documents will generally be removed from a plurality of storage locations and moved concurrently under the control of control system 30 to the escrow area 66. As shown schematically in Figure 54, each of the documents removed from a storage area is moved from the respective canister transport to the adjacent remote transport segment and directed upward by the gate to the central transport. In the central transport the documents each pass the identification device 88. The type and character of the document is again determined prior to being dispensed to the customer. The flow of documents during this dispensing (document recovery) operation is represented by Arrows "E" in Figure 54. Of course as can be appreciated from the foregoing discussion, if at any time in the processing of documents which are to be provided to a customer, an improper or unidentifiable document is found, it may be routed to the delivery/reject area 60 for reprocessing or return into the machine.

The recovery of documents from a storage area is represented by the sequence of operations shown in Figures 55-61 in connection with storage area 102. For purposes of clarity and simplicity document 480, which was previously deposited at the top of the stack 466, will be dispensed in this exemplary sequence of events.

As shown in Figure 55 in the initial position of storage area 102, bin door 442 is disposed downward by its associated mechanism. The inward projections of the fingers 470 and 472 extend in the recesses in the inner surface 474 of the bin door. The fingers along with the inner surface of the bin door retain the top of the stack which is bounded by document 480. The stack 466 is biased upwardly by spring action of push plate 468.

In the next step in dispensing the document, the fingers 470 and 472 are moved outward relative to the stack by their mechanism responsive to signals from the control system. This enables document 480 at the upper surface of the stack 466 to be engaged with the projections which bound inner surface 474 of the bin door 422.

As next shown in Figure 57 the front of the bin door 422 is moved upward by its mechanism. The take away wheels 482 are moved upward to engage the feed wheels 458 and 460 (see Figure 59). Likewise stripper roll 484 is moved by its associated moving mechanism in upward direction as shown in the drawing to engage feed belt 462.

It should be noted with regard to Figure 59 that feed wheel 460 includes an inner portion which has a high friction segment 486 thereon. High friction segment 486 comprises a band of resilient material that extends radially outward further than other portions of the outer circumference of the feed wheel and part way circumferentially about the inner portion of the wheel. Feed wheel 458 has a similar high friction segment 488 thereon. The high friction segments extend through the openings in the bin door provide gripping engagement with a top document in the stack when the feed wheels are positioned to place the high friction segments in engagement with the top document.

It should further be understood that stripper roll 484 includes a one way clutch type mechanism. This one way clutch mechanism enables the stripper roll to rotate in a manner which allows a document to readily move into the storage area 102. The clutch associated with stripper roll 484 is oriented to resist movement of documents out of the storage area. In this manner the stripper roll 484 serves as a stripper device which generally moves only the single document at the very top of the stack and strips or prevents other documents from moving out of the storage area. This is achieved because the high friction segments provide greater force moving the single document in a first direction out of the storage area than the resistance applied to the document by the stripper roll. However other documents tending to move with the first document are separated.

As is also shown in Figures 57 and 59, thumper wheels 454 and 456 include an outward extending portion. These outward extending portions are preferably generally angularly aligned and moved by a driving mechanism so that all of the extending portions extend through the respective openings in the

bin door simultaneously. As is shown in Figure 59 these extending portions are generally in angular alignment with the arcuate high friction segments on the feed wheels and likewise serve as engaging members for engaging and moving the top document in the stack.

5           As shown in Figure 58 to pick a document the feed wheels and thumper wheels are rotated so that the radially outward extending portions of the thumper wheels and the radially outward extending high friction segments of the feed wheels engage document 480 at the top of stack 466. The action of the thumper wheels, feed wheels, take away wheels and stripper roll, operate  
10       to separate document 480 from the stack and move it in a first direction from the storage area as shown in Figure 58. The preferred embodiment of the apparatus is generally sized so that a single rotation of the feed wheels and thumper wheels is sufficient to move a document from the storage area. Once the document is moved from the storage area it engages the belts and  
15       projections on the adjacent bin door or transport portion and moves in engagement therewith. The bin door 442 is again closed and the take away wheels and stripper roll moved by their associated mechanisms so as to be retracted from the canister. The fingers 470 and 472 are moved upward and inward to again engage the top of the stack.

20           As document 480 is moved from storage area 102 the transmissivity of light through the document is sensed. The transmission of light through the document is sensed by a sensor 490. Sensor 490 is preferably a receiver similar to sensor 464 and is positioned on the bin door or other structure covering the storage area or otherwise in the first direction from storage area  
25       102. Emitter 492 mounted on the machine emits sufficient light so that it can be determined if a double note has been removed from the stack.

          Emitter 492 and sensor 490 are connected to the control system which is programmed to recognize when a double document has been picked from the storage area. This is preferably done by determining if the thickness of a  
30       sheet picked is above a predetermined thickness. The machine may operate in a number of ways depending on the programming of the control system to deal

with this occurrence. If the document has been removed entirely from the stack, the document may be reversed in direction and deposited back into the stack. Then an attempt made to again remove it. Alternatively, in an attempted second picking operation the feed wheels may be oscillated back and forth as the note is being picked to minimize the possibility that two notes will be removed together. This may be done automatically by the control system in some conditions where documents are known to have a particularly high affinity or surface tension which makes them difficult to separate.

Finally, in the event that repeated attempts to pick a single note from the storage area are unsuccessful, the machine may operate to route the picked document(s) to another storage area or to the dump area 132. The machine may then proceed to pick a next note from the stack. The programming of the machine 10 is preferably established to minimize the delay associated when a picking problem is encountered.

After the document 480 has been successfully removed from the storage area 102 it is transported to the remote transport segment 110 and is routed by the gate 118 toward the central transport. Document 480 along with other documents passes the identification device 88 which confirms the identity of each document. The documents are deposited in the escrow area 66 where an escrow stack 494 is accumulated. Thereafter as schematically represented in Figure 62, escrow stack 494 is moved upwardly in the input/output area 50 of the machine. Gate 54 is opened and the stack is delivered to the customer through opening 52.

The transaction flow executed by the control system for carrying out the operations of the machine in a withdrawal transaction is represented in Figure 69 and 70. As is the case with the deposit transaction, the machine first goes through a customer identification sequence represented by a step 134 in which the customer operating the machine is identified to resolve their account data. This customer ID sequence is not usually executed again when the customer has operated the machine to conduct an immediately prior transaction as the customer account data has already been resolved and is



available in the memory of the machine. After the customer has identified themselves, the machine goes through the main ATM transaction sequence 136, as previously described.

5 The customer next indicates at a step 496 through the customer interface that they wish to conduct a withdrawal transaction. The amount of the withdrawal is then received by the machine based on customer inputs at a step 498. At a step 500 the machine operates to determine if the amount of the withdrawal that the customer has requested is authorized by the programming of the machine and/or the programming of a computer of a remote debit or  
10 credit transaction processing system which is in communication with the machine via phone link, radio link, lease line or other suitable communication means. If the withdrawal is not authorized, the machine returns to the main sequence and provides instructions to the customer.

15 If the amount of the withdrawal is authorized, the control system of the machine looks up the storage locations of the various bill denominations at a step 502, and calculates a bill mix to be provided to the customer at a step 504. It should be noted that in some embodiments of the invention, which are intended to be used primarily by commercial customers, the customer may be allowed to select the mix of denominations of bills that the customer will  
20 receive. This is done by the control system using programmed prompts displayed on the customer interface. The customer provides inputs through the customer interface which indicate the quantity of each bill type they desire. If however the machine does not provide that option or the customer does not provide a specific denomination selection, the machine will operate to  
25 determine the number of various types of bills that it has available and will provide bills to the customer in denominations which will minimize the probability that the machine will run out of bills of any particular type.

30 The machine next proceeds to a step 506 in which the control system operates to pick notes from the various storage areas. As indicated by phantom step 508, the picking operations are executed concurrently in the preferred embodiment of the invention. Multiple bills may be picked from the

various storage locations and moved as a stream of separated notes through the remote transport segments and into the central transport of the machine.

For each picking operation, after the note is picked a step 510 is executed to sense for double notes having been picked from a storage location.

5 If a double is sensed at a step 512 the note is retracted at a step 514 and an effort is again made to pick a single note. If however in step 512 a single bill is sensed the bill is released in a step 516. In step 516 the note is released in coordinated relation with the other notes by the control system to assure that each note reaches the central transport of the machine in spaced relation with  
10 the other notes. However the spacing is such that the notes move concurrently and are delivered into the escrow location at high speed.

An analysis of each passing note is done by the identification device 88 which is indicated at a step 518. If the note is recognized as proper at a step 520, the note is routed to the escrow area 66 at a step 522. If the note is not  
15 recognized in step 520 or is improper, it is routed to delivery/reject area 60 in a step 524, or to another area designated in the programming of the machine. The failure to identify a note which has come from a storage location is an unusual event. This is because each stored note has usually been twice previously identified. Problems may arise when the note was loaded into the  
20 canister outside the machine. If a note is rejected, the transaction flow of the described embodiment proceeds to an error recovery step 526. This error recovery program may include routing the note back through the central transport to a designated storage location for later analysis.

Notes are delivered into the escrow area until all the notes which  
25 respond to the withdrawal request by the customer have been delivered. The completion of the delivery is checked at a step 528. A check is then made at a step 530 to determine if all the notes that have been delivered have been properly identified. If not and there are notes in the reject area, the error recovery step 526 is executed.

30 If however the notes have all been properly identified the escrow stack corresponding to stack 494 in Figure 62 is moved to the delivery position in a

step 532 which aligns the escrow area with the opening in the housing. The inner gate is then closed at a step 534. The front gate is opened at a step 536 and the transport belts move to deliver the notes to the customer at a step 538.

At a step 540 a determination is made based on reading from sensors  
5 148 and 150 as to whether the stack of notes has been taken by the customer. If so, the front gate is closed at a step 542. The control system then operates to have the withdrawal debited to the customer's account in the memory of the machine and/or in a memory of a remote transaction processing system. The transaction flow then returns to the main ATM sequence at a step 544.

10 If however the notes are not taken by the customer routines may be executed to prompt the customer through the customer interface to remove the notes. However if the customer does not take the notes, then step 546 is executed to retract the notes into the machine. The front gate is closed at a  
15 step 548 and the machine then proceeds to the error recovery routine. This may include for example, storing the notes in a particular storage location. Alternatively it may involve reversing the withdrawal transaction requested by the customer and placing the notes again back in the various storage areas by running them through the central transport. As previously discussed, a record  
20 of the incomplete transaction by the customer may be stored in the machine or elsewhere in an operatively connected computer system so the customer may complete the transaction when they later access this machine or another machine connected to the system.

An advantage of one preferred embodiment of the present invention is its ability to operate at high speeds. This is achieved through the architecture  
25 of the control system 30 which is schematically represented in Figure 63. The preferred embodiment of the system uses a control system which includes a terminal processor 548. The terminal processor contains the general programming of the machine as well as the programs necessary for operation of the communication functions with other systems and other functions that  
30 the machine carries out. As indicated in Figure 63, terminal processor 548 is in operative connection with a data store which includes programmed

instructions and data. Terminal processor 548 is in communication through appropriate interfaces with various hardware devices 550.

Terminal processor 548 is also in operative communication with a module processor 552. Module processor 552 orchestrates the operations carried out by the plurality of module controllers 554, 556, 558, 560, 562 and 564. As indicated, module processor 552 is also in operative connection with its own respective data store which holds its programmed instructions and data. Likewise each of the module controllers preferably include data storage for holding various programmed instructions and data. The module processor 552 is operatively connected to each of the module controllers through a data bus 566. The module controllers each communicate through the data bus only with the module processor 552, and the module processor communicates directly with each module controller. Each module controller has associated therewith hardware devices indicated 567. Each module controller has associated therewith its own respective types of hardware devices which it is responsible for operating and controlling.

In operation of the system each module controller operates programs to execute particular tasks associated with each hardware device that is connected to it. This may be for example, a particular function associated with moving a mechanism or a document. These tasks are coordinated with other tasks executed through the module controller concerning related hardware. The movement of documents concurrently however is coordinated by the module processor 552 operating to send the control signals to the various module controllers, so that document handling functions are carried out in a timed and coordinated relation. The terminal processor 548 controls the operation of the module processor to carry out the particular transactions which are indicated by the terminal programming. As a result of this configuration, documents are enabled to be handled concurrently, yet independently throughout the machine which greatly speeds the operation of storing and retrieving documents.

Thus the preferred embodiment of the present invention achieves the above stated objectives, eliminates difficulties encountered in the use of prior

devices, systems and methods, and attains the desirable results described herein.

In the foregoing description certain terms have been used for brevity, clarity and understanding. However, no unnecessary limitations are to be implied therefrom because such terms are used for descriptive purposes and are intended to be broadly construed. Moreover the foregoing descriptions and illustrations are by way of examples and the invention is not limited to the details shown or described.

In the following claims any feature described as a means for performing a function shall be construed as encompassing any means capable of performing the recited function and shall not be limited to the means shown and described in the foregoing description as performing the recited function, or mere equivalents thereof.

Having described the features, discoveries and principles of the invention, the manner in which it is constructed and operated and the new and useful results attained; the new and useful structures, devices, elements, arrangements, parts, combinations, systems, operations, methods and relationships are set forth in the appended claims.

## CLAIMS

We claim:

1. Apparatus in an automated banking machine comprising:

5 a sheet path, wherein sheets move in generally a first direction in the sheet path;

a first sheet sensor and a second sheet sensor adjacent the sheet path, wherein the first and second sheet sensors are generally disposed from each other in a transverse direction relative to the first direction;

10 a first sheet brake and a second sheet brake adjacent the sheet path, wherein the second sheet brake is generally transversely disposed from the first sheet brake, wherein each sheet brake is selectively operative to change relative speed of disposed areas of a sheet adjacent to the sheet brakes as the sheet moves adjacent to the sheet brakes in the sheet path; and

15 a control system in operative connection with the first and second sheet sensors and the first and second sheet brakes, wherein the control system is operative responsive to sensing a sheet with the first and second sensors to selectively actuate the first and second sheet brakes to change the orientation of the sheet relative to the sheet path.

20 2. The apparatus according to claim 1 wherein the control system is operative to actuate the first sheet brake responsive to sensing the sheet with the first sheet sensor.

3. The apparatus according to claim 2 wherein the control system is operative to actuate the second sheet brake responsive to sensing the sheet with the second sheet sensor.

5 4. The apparatus according to claim 3 wherein the sheet path is adapted to move sheets, which sheets each include a leading edge, and wherein the control system is operative to actuate the sheet brakes to align the leading edge of each sheet in generally the transverse direction relative to the first direction.

10 5. The apparatus according to claim 1 wherein the sheet path is adapted to move sheets, which sheets include a first generally flat planar face bounding the sheet, and wherein the first and second sheet brakes selectively change the relative speed of first and second areas on the first face on the sheet, respectively.

15 6. The apparatus according to claim 1 wherein the sheet brakes are selectively operative to slow the sheet in the areas of the sheet in engagement with the sheet brakes, and wherein the control system is operative to selectively actuate and release the sheet brakes such that each sheet is released by the first and second sheet brakes and is disposed in the first direction from all other sheets in the sheet path.

20 7. The apparatus according to claim 1 and further comprising a generally transversely extending guide, wherein the first and second sheet brakes are transversely movable relative to the sheet path in supporting connection with the guide.

25 8. The apparatus according to claim 7 wherein the sheet path is adapted to move sheets therein, each sheet including a pair of opposed side edges, the side edges extending generally in the first direction along the sheet

path, and further comprising an upstream sensing device, wherein the upstream sensing device is operative to sense a position of at least one of the side edges of each sheet, and wherein the upstream sensing device is disposed in the sheet path in a direction opposed of the first direction relative to the first sheet brake, and wherein the upstream sensor is in operative connection with the control system, and further comprising a transverse moving device in operative connection with the control system, wherein the transverse moving device is operative to transversely move the first sheet brake along the guide, and wherein the control system is operative to cause the transverse moving device to move the first sheet brake transversely in the sheet path responsive to a position of a side edge of a sheet sensed by the upstream sensor.

9. The apparatus according to claim 8 wherein the upstream sensor is operative to sense positions of both side edges of the sheets, and wherein the transverse moving device is operative to transversely move the first sheet brake responsive to the positions of both side edges.

10. The apparatus according to claim 9 wherein the first sheet brake is generally transversely movable in supporting connection with the guide, and wherein the second sheet brake is in operative connection with the transverse moving device and is selectively transversely movable thereby, and wherein the first and second sheet brakes are transversely moved responsive to the positions of both side edges of the sheet sensed by the upstream sensor.

11. The apparatus according to claim 10 wherein each sheet moved in the sheet path has a center portion, wherein the center portion is generally centered between the side edges, and wherein the first and second sheet brakes are moved transversely by the transverse moving device such that the first area engaged by the first sheet brake generally engages each sheet a first distance in a first transverse direction from the center portion of the sheet, and the second



area engaged by the second sheet brake is generally the first distance in an opposed transverse direction from the center portion of the sheet.

12. The apparatus according to claim 11 and further comprising a shuttle, wherein the shuttle is in supporting transversely movable connection with the guide, and wherein the first and second sensors and first and second sheet brakes are in supporting connection with the shuttle.

13. The apparatus according to claim 1 and further comprising a drive shaft and a drive in operative connection with the drive shaft, wherein the drive is operative to rotate the drive shaft, and wherein the first sheet brake includes a first movable member and a first mechanism, wherein the first movable member is operative to engage the sheets moving in the sheet path, wherein the first mechanism is operative to selectively operatively engage and disengage the first movable member and the drive shaft, wherein the first movable member slows when it is operatively disengaged from the drive shaft by the first mechanism.

14. The apparatus according to claim 13 wherein the second sheet brake includes a second movable member and a second mechanism, wherein the second movable member is operative to engage the sheets moving in the sheet path, and wherein the second mechanism is operative to selectively operatively engage and disengage the second movable member and the drive shaft, wherein the second movable member slows when it is operatively disengaged from the drive shaft by the second mechanism.

15. The apparatus according to claim 13 wherein the drive shaft extends generally transversely relative to the sheet path, and wherein the first movable member is movable in the transverse direction in supporting connection with the drive shaft.

16. The apparatus according to claim 14 wherein the drive shaft extends generally transversely relative to the sheet path, and wherein the first and second movable members are both movable transversely in supporting connection with the drive shaft.

5 17. The apparatus according to claim 13 and further comprising an idler shaft, wherein the idler shaft extends generally transversely across the sheet path, and wherein sheets passing in the sheet path pass between and in engagement with the first movable member and the idler shaft.

10 18. The apparatus according to claim 17 wherein the idler shaft comprises a plurality of independently rotatable generally transversely adjacent shaft segments, wherein the shaft segments extend in the sheet path.

15 19. The apparatus according to claim 1 and further comprising a first drive mechanism, and wherein the first sheet brake includes a first movable member, and wherein the first drive mechanism is in operative connection and moves the first movable member, and wherein the first movable member is operative to engage the sheets moving in the sheet path, whereby sheets are moved in the sheet path in engagement therewith, and further comprising a first brake mechanism, wherein the first brake mechanism is selectively operative to slow the first movable member.

20 20. The apparatus according to claim 19 and further comprising a second drive mechanism, and wherein the second sheet brake includes a second movable member, and wherein the second drive mechanism is in operative connection with the second movable member and moves the second movable member, wherein the second movable member is operative to engage  
25 sheets moving in the sheet path, whereby sheets are moved in the sheet path in engagement therewith, and further comprising a second brake mechanism,

wherein the second brake mechanism is selectively operative to slow the second movable member.

21. The apparatus according to claim 1 and further comprising:

5 a centering sensor in the sheet path adjacent the first and second sheet brakes, wherein the centering sensor is operative to sense at least one transverse extreme of the sheet; and

10 a transverse moving device in operative connection with the centering sensor, wherein the transverse moving device is operative responsive to the centering sensor to move the sheet transversely responsive to the position of the one transverse extreme.

22. The apparatus according to claim 21 wherein the centering sensor is operative to sense two transverse extremes of the sheet, and wherein the transverse moving device is operative to move the sheet to a generally  
15 transversely centered position relative to the sheet path.

23. The apparatus according to claim 22 and further comprising a shuttle, and wherein the shuttle includes the first and second sheet brakes, and wherein the transverse moving device is operative to transversely move the sheet relative to the sheet path in engagement with the first and second sheet  
20 brakes.

24. The apparatus according to claim 21 wherein the centering sensor comprises a pair of centering sensor devices, wherein each sensor device extends on transversely opposite sides of the sheet path relative to the other sensor device, and wherein each sensor device is operative to sense one  
25 transverse edge of the sheet.

25. The apparatus according to claim 21 and wherein the centering sensor includes an emitter device and a receiver device, wherein the emitter device extends on one sheet side of the sheet path and the receiver device extends on an opposed side of the sheet path, wherein sheets moving in the sheet path pass between the emitter device and the receiver device, and wherein the centering sensor is in operative connection with the control system, wherein the control system is operative to change the intensity of the emitter device responsive to the centering sensor sensing a sheet adjacent thereto.

26. The apparatus according to claim 1 and further comprising an idler shaft extending generally transversely in the sheet path and opposed of the sheet brakes, wherein sheets moving in the sheet path pass between the sheet brakes and the idler shaft, and wherein sheets in engagement with the sheet brakes are also in engagement with the idler shaft, and further comprising a transverse moving device, wherein the transverse moving device is in operative connection with the control system, and wherein the transverse moving device is operative to selectively move the sheet brakes in the transverse direction, wherein sheets in engagement with the sheet brakes are moved transversely in supporting connection with the idler shaft.

27. The apparatus according to claim 26 and further comprising a positioning sensor in the sheet path adjacent to the first and second sheet brakes, wherein the positioning sensor senses a transverse position of the sheet relative to the sheet path, and wherein the transverse moving device is in operative connection with the positioning sensor, and wherein the transverse moving device is operative to move the sheet in engagement with the first and second sheet brakes responsive to the transverse position of the sheet sensed by the positioning sensor.

28. The apparatus according to claim 26 wherein the idler shaft comprises a plurality of transversely disposed independently rotatable shaft segments.

29. A method comprising the steps of:

- 5 (a) moving a sheet in a first direction in a sheet path, the sheet being bounded by a leading edge and a pair of transversely disposed side edges;
- (b) sensing the sheet with a first sheet sensor in the sheet path;
- 10 (c) relatively slowing the sheet in a first area with a first sheet brake responsive to sensing the sheet with a first sheet sensor;
- (d) sensing the sheet with a second sheet sensor transversely disposed of the first sheet sensor in the sheet path;
- 15 (e) relatively slowing the sheet in a second area transversely disposed of the first area with a second sheet brake responsive to sensing the sheet with the second sheet sensor.

30. The method according to claim 29 and further comprising the steps of:

- 20 (f) aligning the leading edge of the sheet in a direction generally transverse of the first direction; and

- (g) releasing the sheet from the first and second sheet brakes.

31. The method according to claim 29 and prior to step (b) further comprising the steps of:

- 5 (f) sensing the sheet with an upstream sensor, wherein the upstream sensor is disposed in a direction opposed of the first direction from the first sheet brake; and
- (g) moving the first sheet brake generally transversely in the sheet path with a transverse moving device, wherein  
10 the first sheet brake is engaged with the sheet and moves the sheet in the transverse direction.

32. The method according to claim 31 wherein step (f) includes sensing both of the pair of transverse side edges of the sheet and step (g) includes moving both the first and second sheet brakes transversely relative to  
15 the sheet path, wherein the first and second sheet brakes engage the sheet between the first and second transverse edges of the sheet.

33. The method according to claim 31 wherein step (f) comprises sensing the sheet with a sensor including an emitter and a receiver, and increasing the intensity of the emitter responsive to sensing the sheet adjacent  
20 to the sensor.

34. The method according to claim 29 wherein a rotating drive shaft extends generally transversely relative to the sheet path, and wherein the first sheet brake includes a first movable member that operatively engages the sheet in step (c), and wherein step (c) includes operatively disconnecting the  
25 first movable member from the drive shaft.

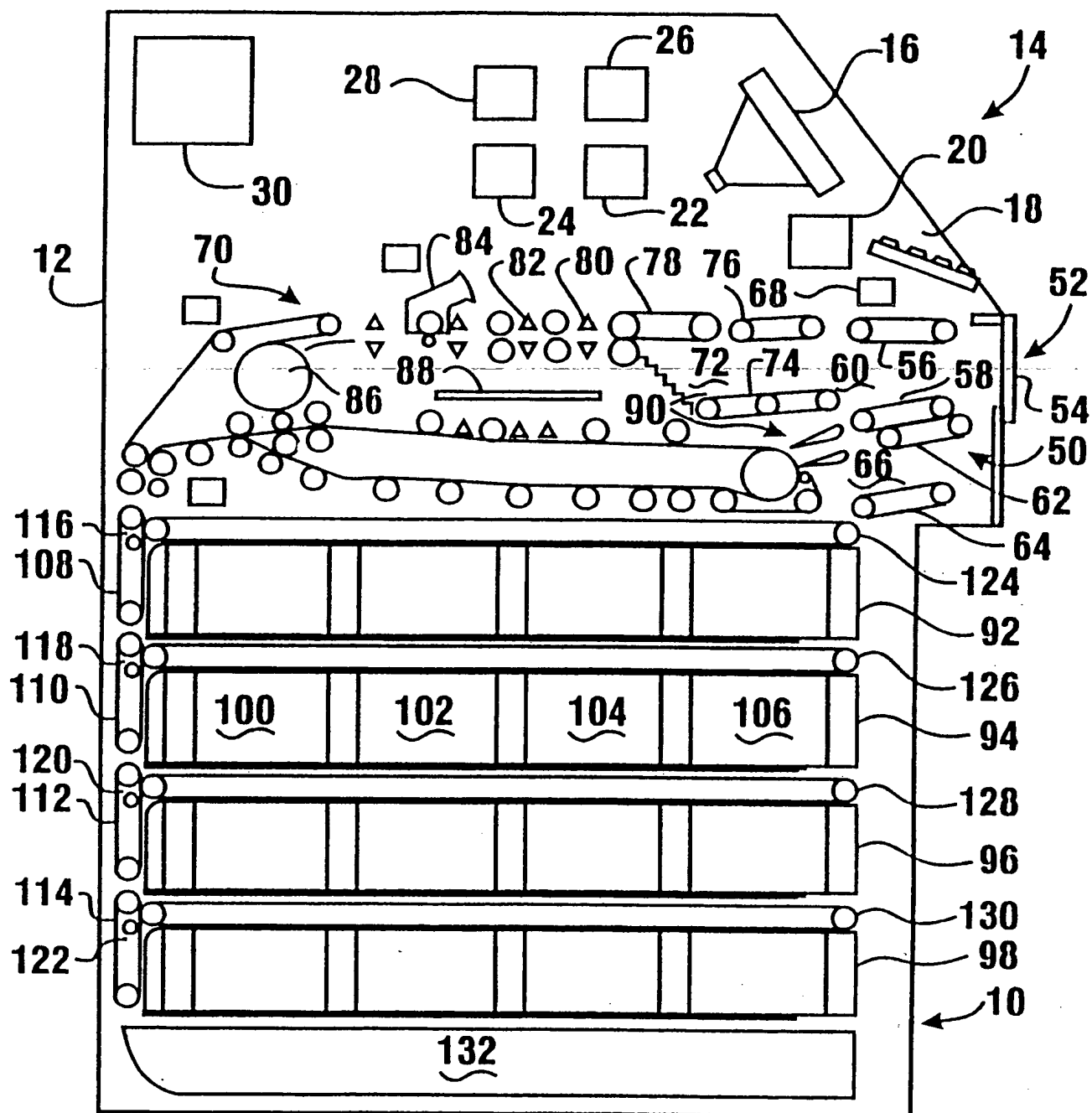
35. The method according to claim 34 wherein step (c) further includes stopping movement of the movable member with an engaging mechanism.

36. The method according to claim 29 and further comprising the steps of:

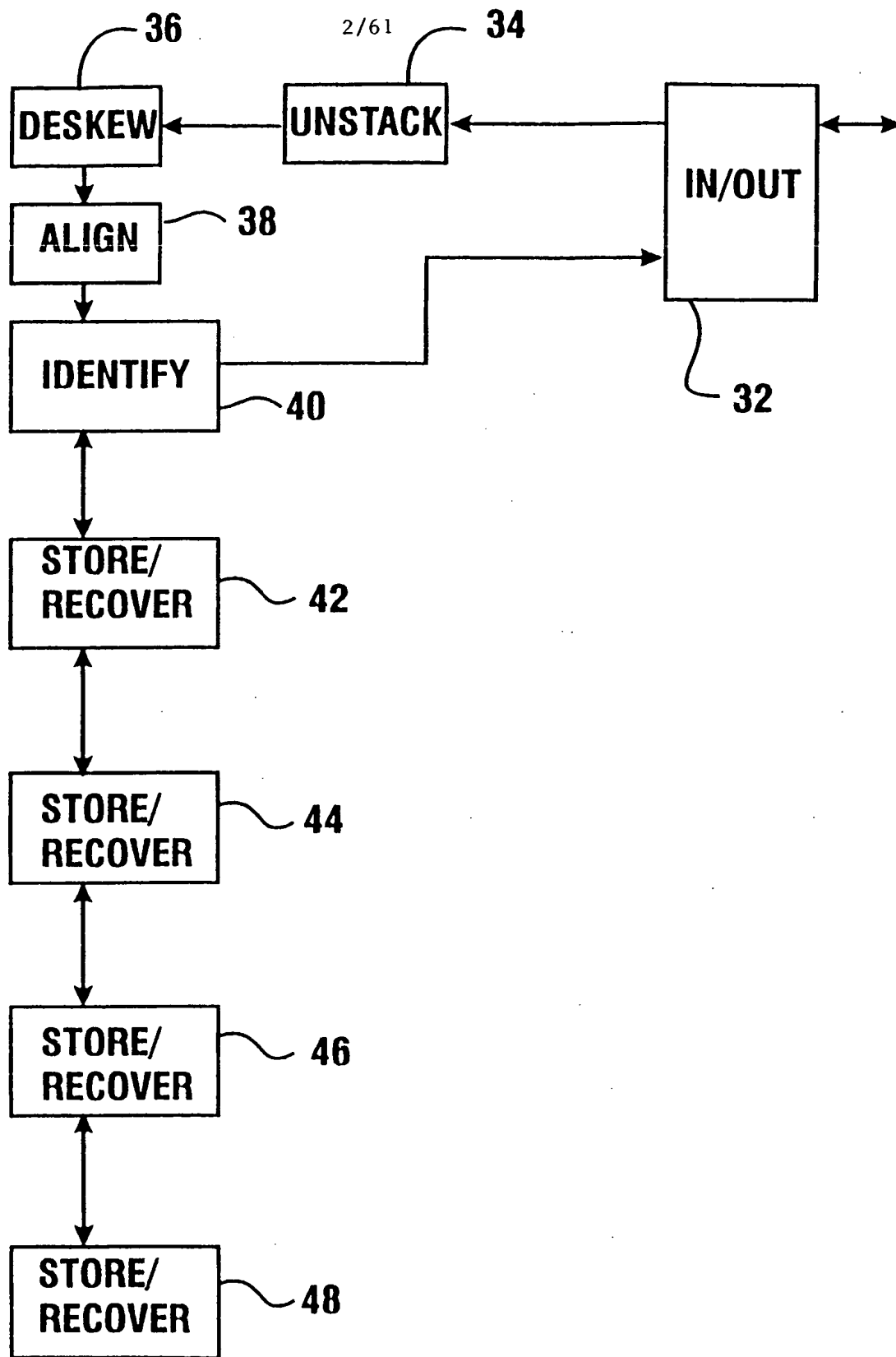
(f) sensing a transverse position of the sheet relative to the sheet path with a centering sensor; and

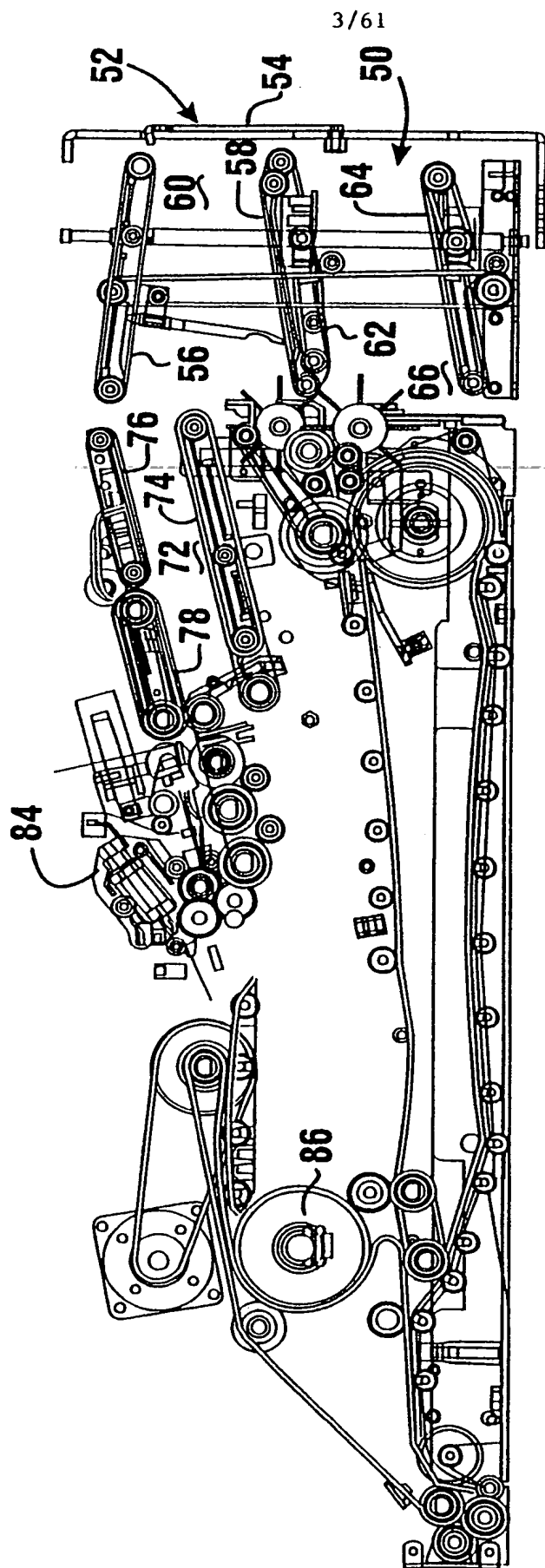
(g) transversely moving the sheet in the sheet path in engaged relation with the first and second sheet brakes responsive to the transverse position of the sheet sensed in step (f).

37. The method according to claim 36 wherein the sheet path includes a plurality of other sheets traveling in the sheet path and further comprising the step of releasing the sheet from the sheet brakes so that the sheet is disposed in the first direction from each of the other sheets in the sheet path.

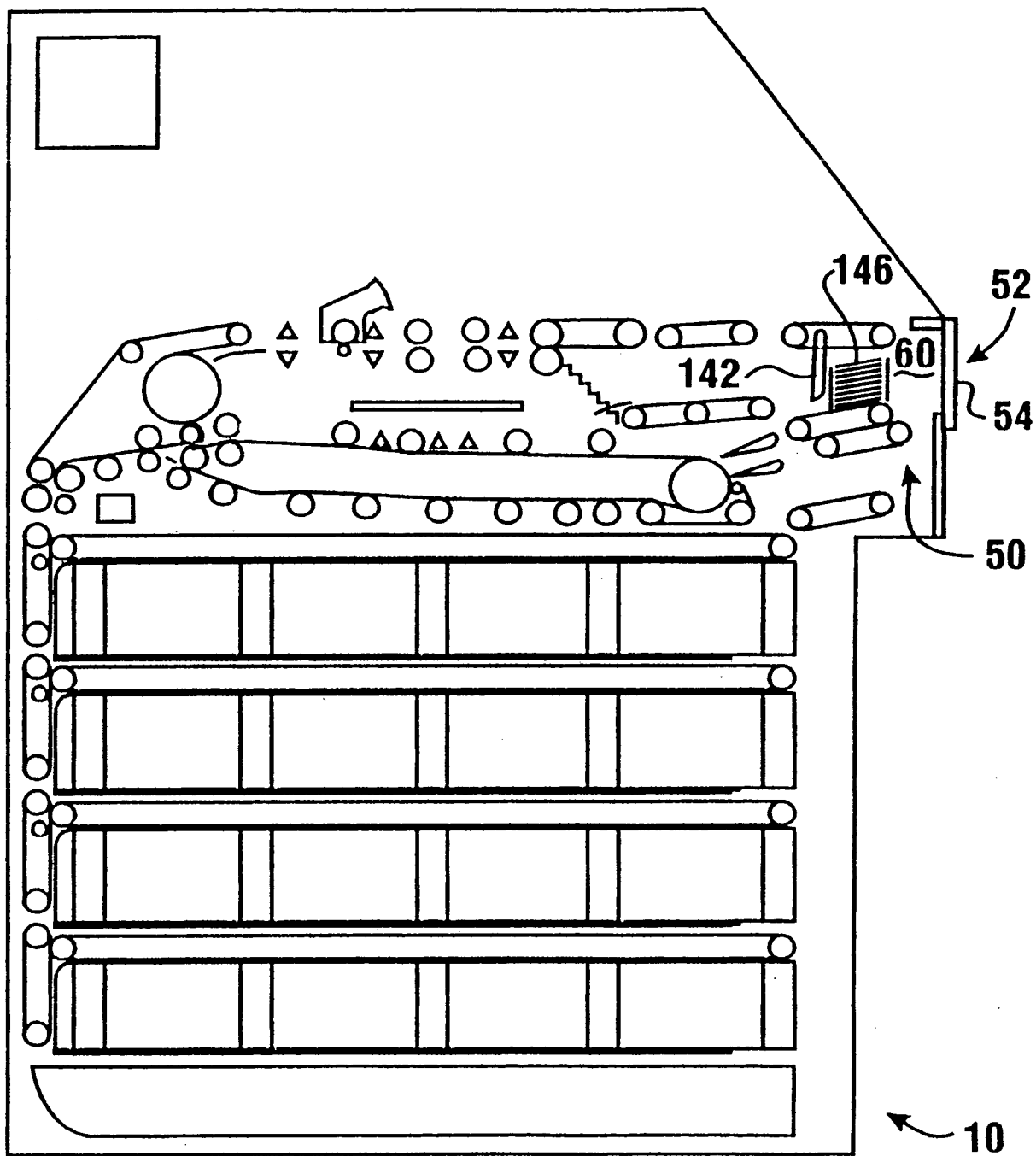
**FIG. 1**



**FIG. 2**

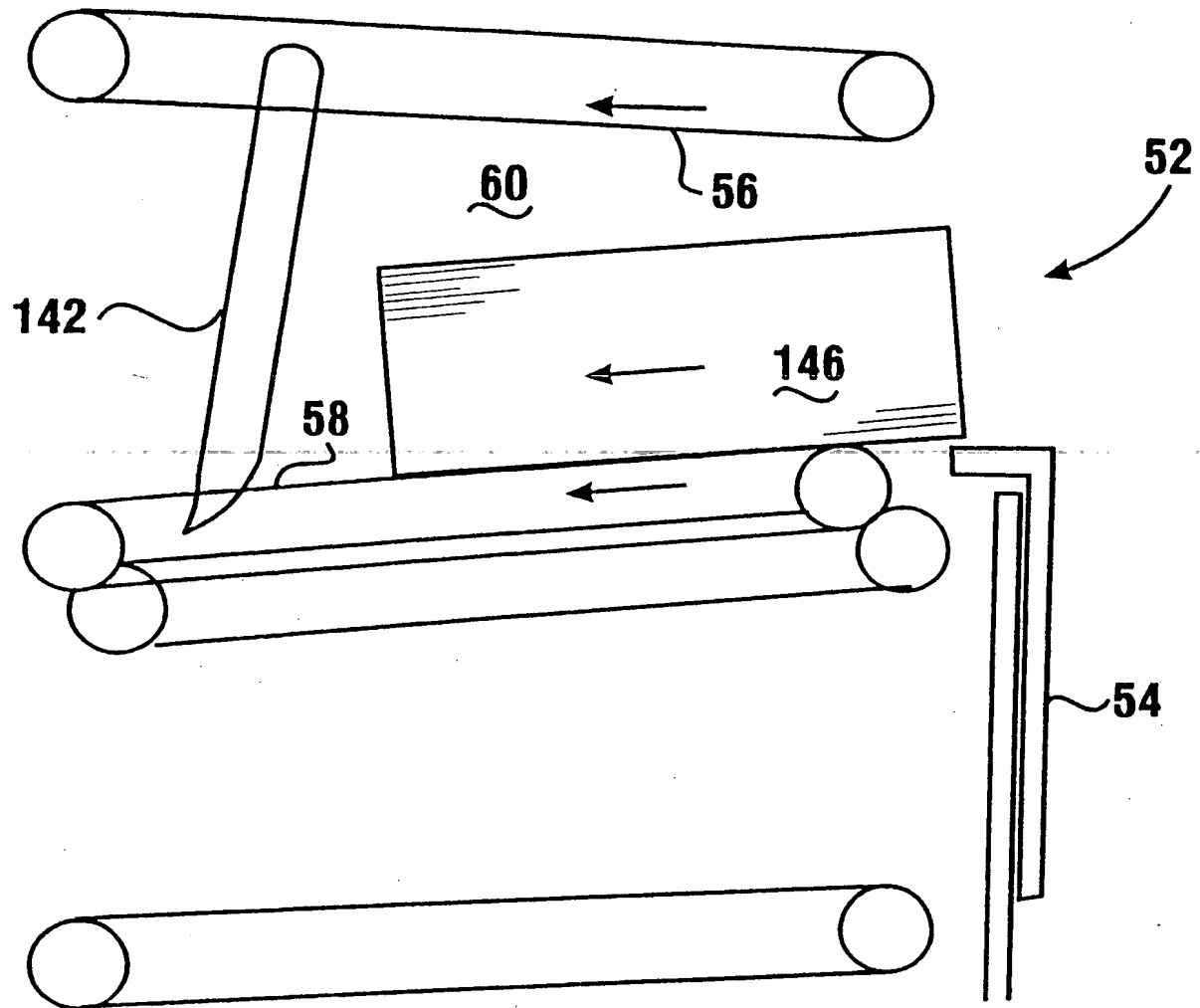


**FIG. 3**



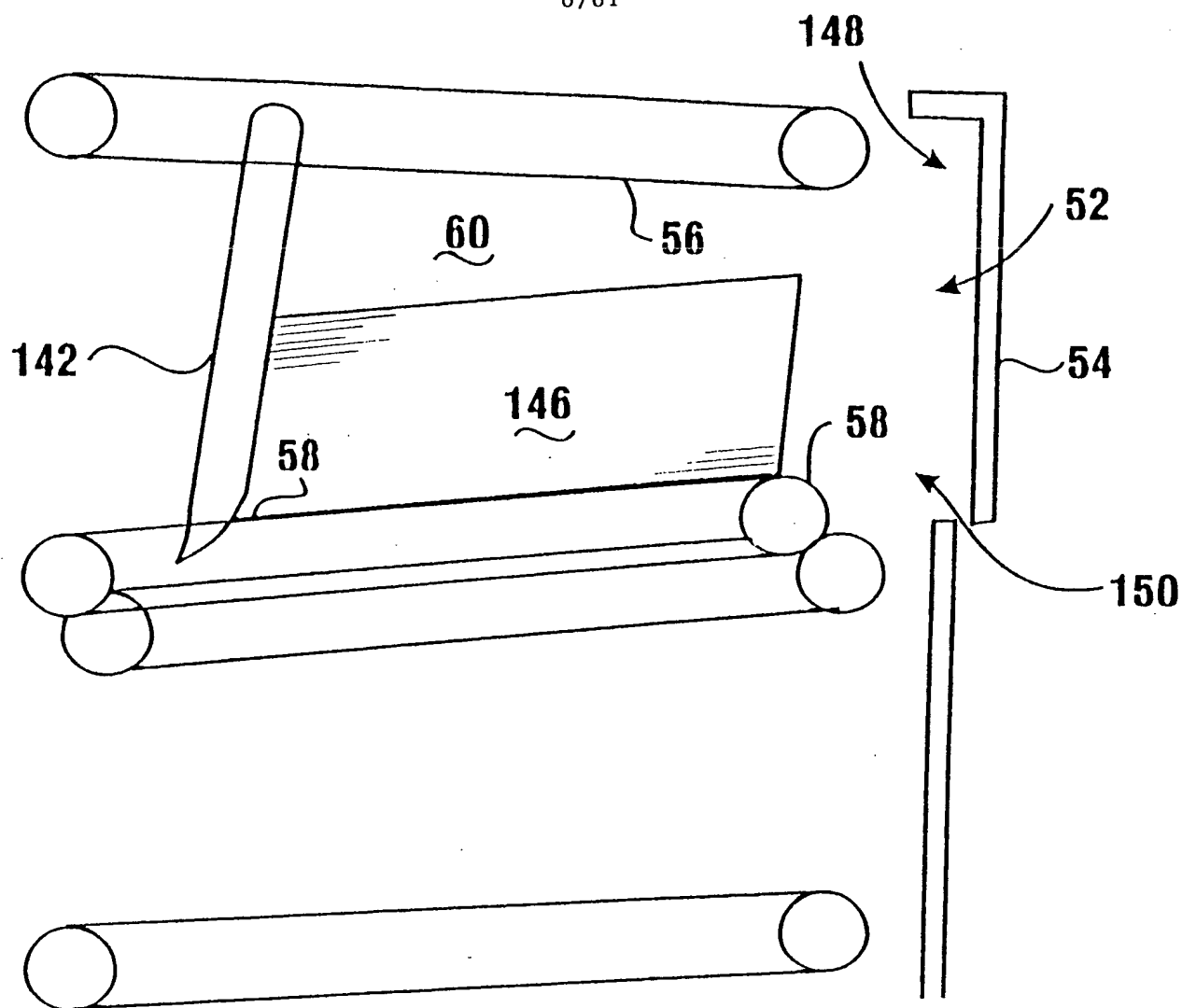
**FIG. 4**

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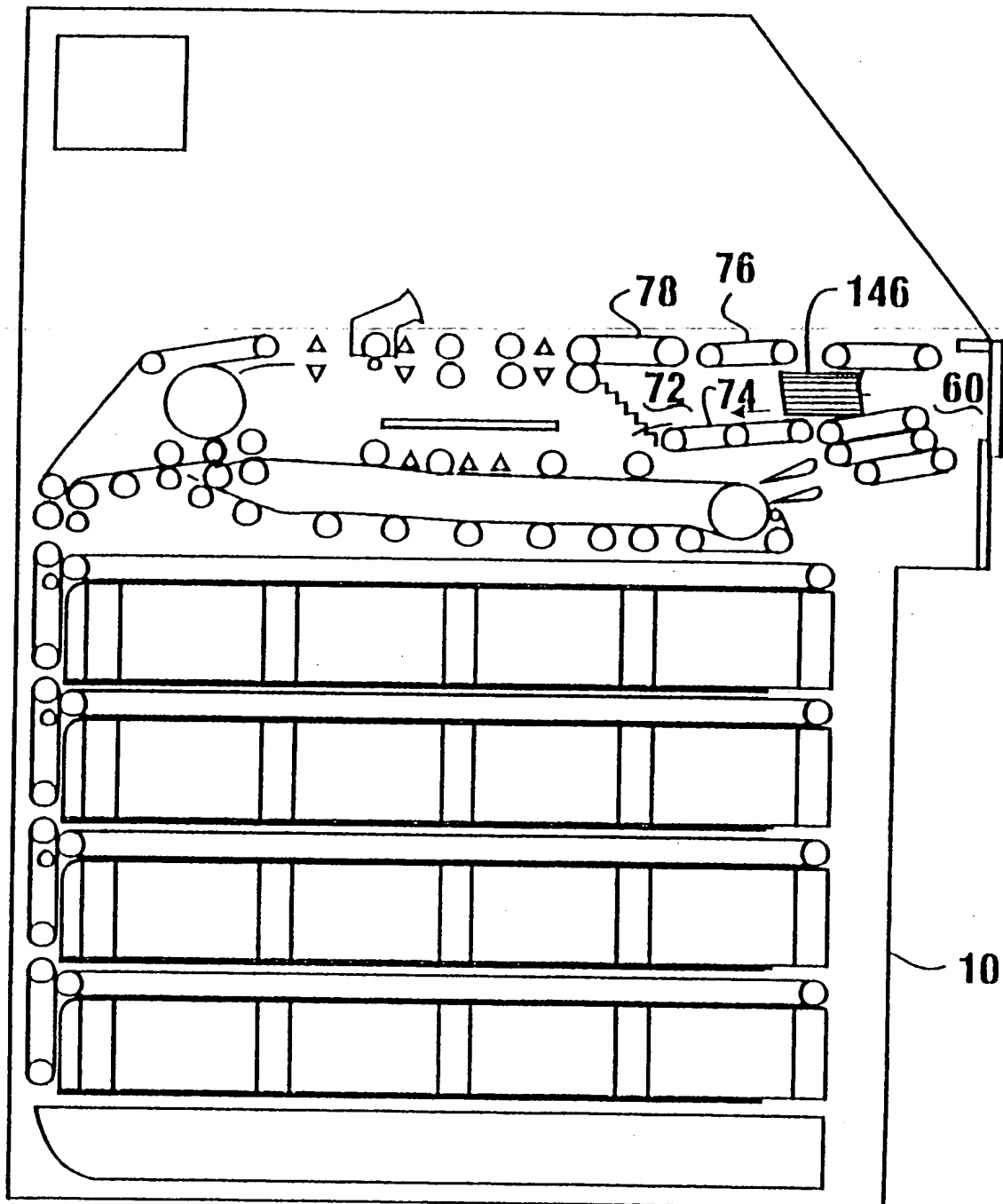
**FIG. 5**

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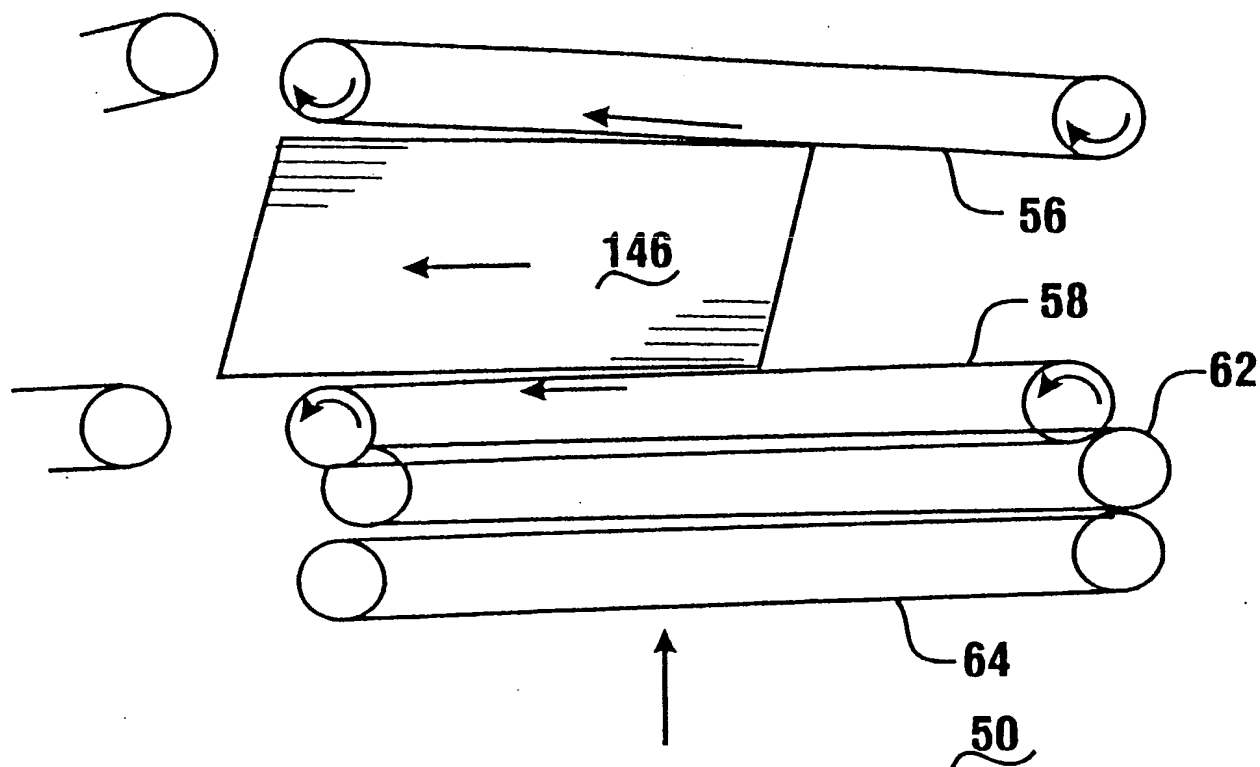
**FIG. 6**

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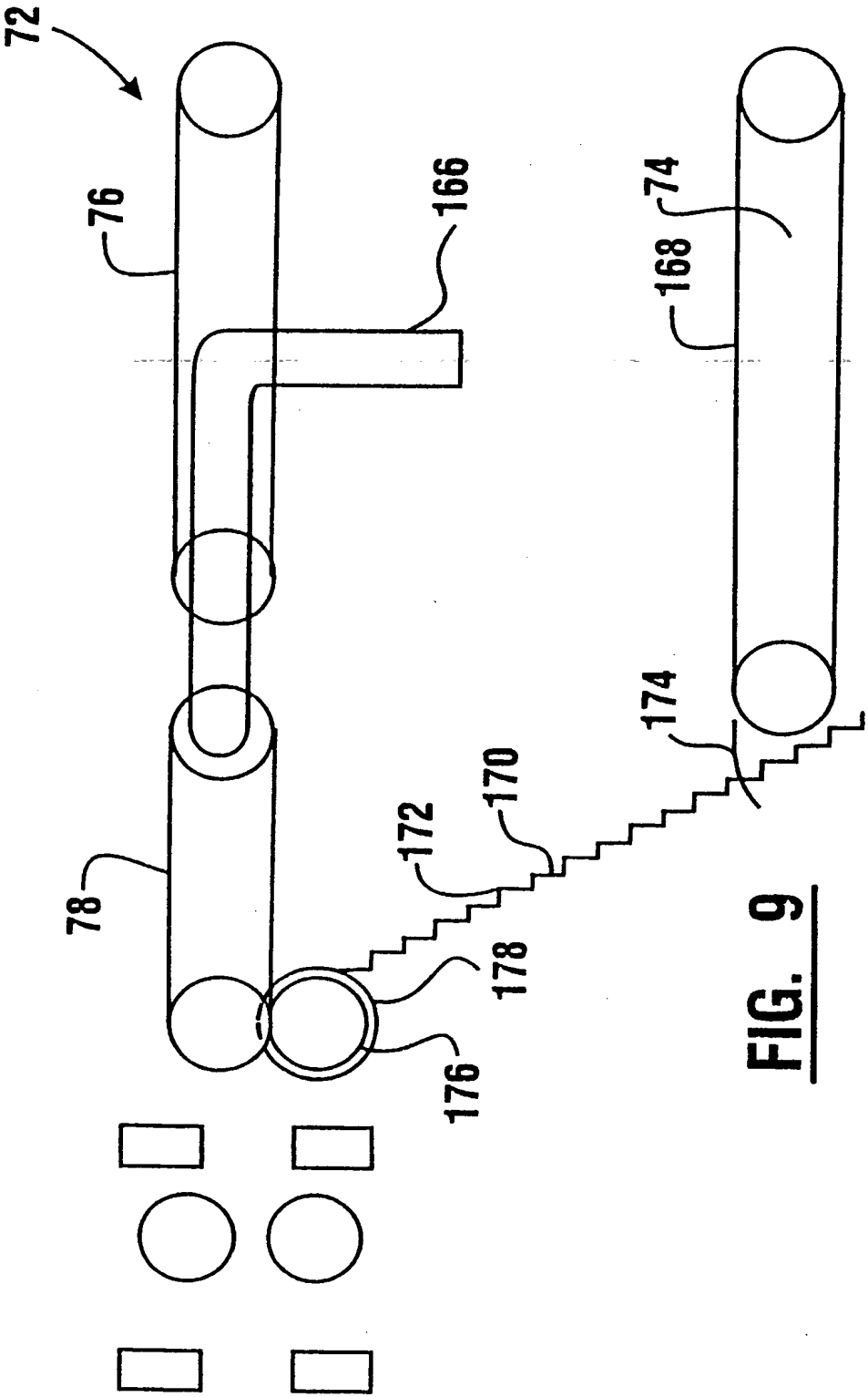
**FIG. 7**

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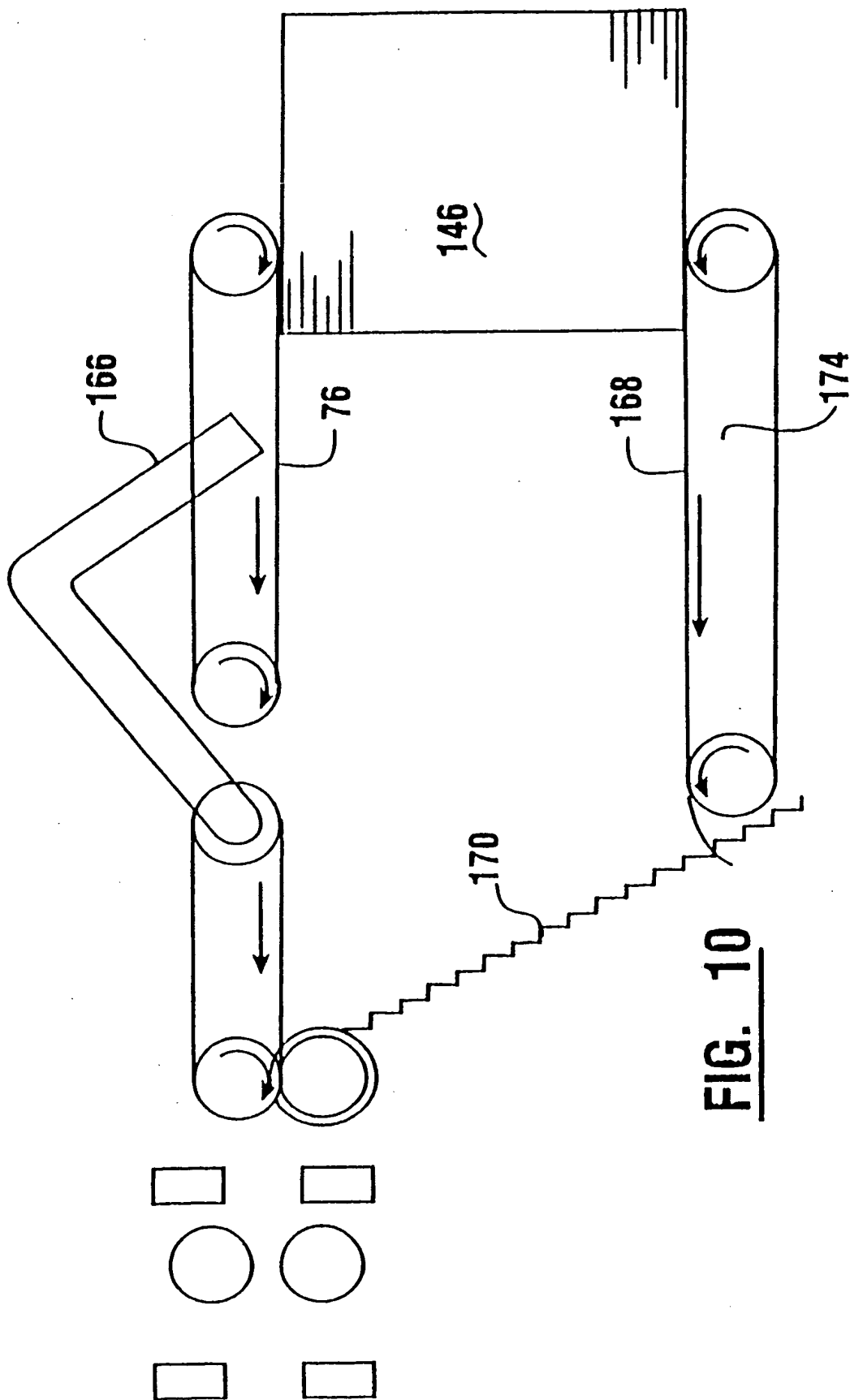
**FIG. 8**

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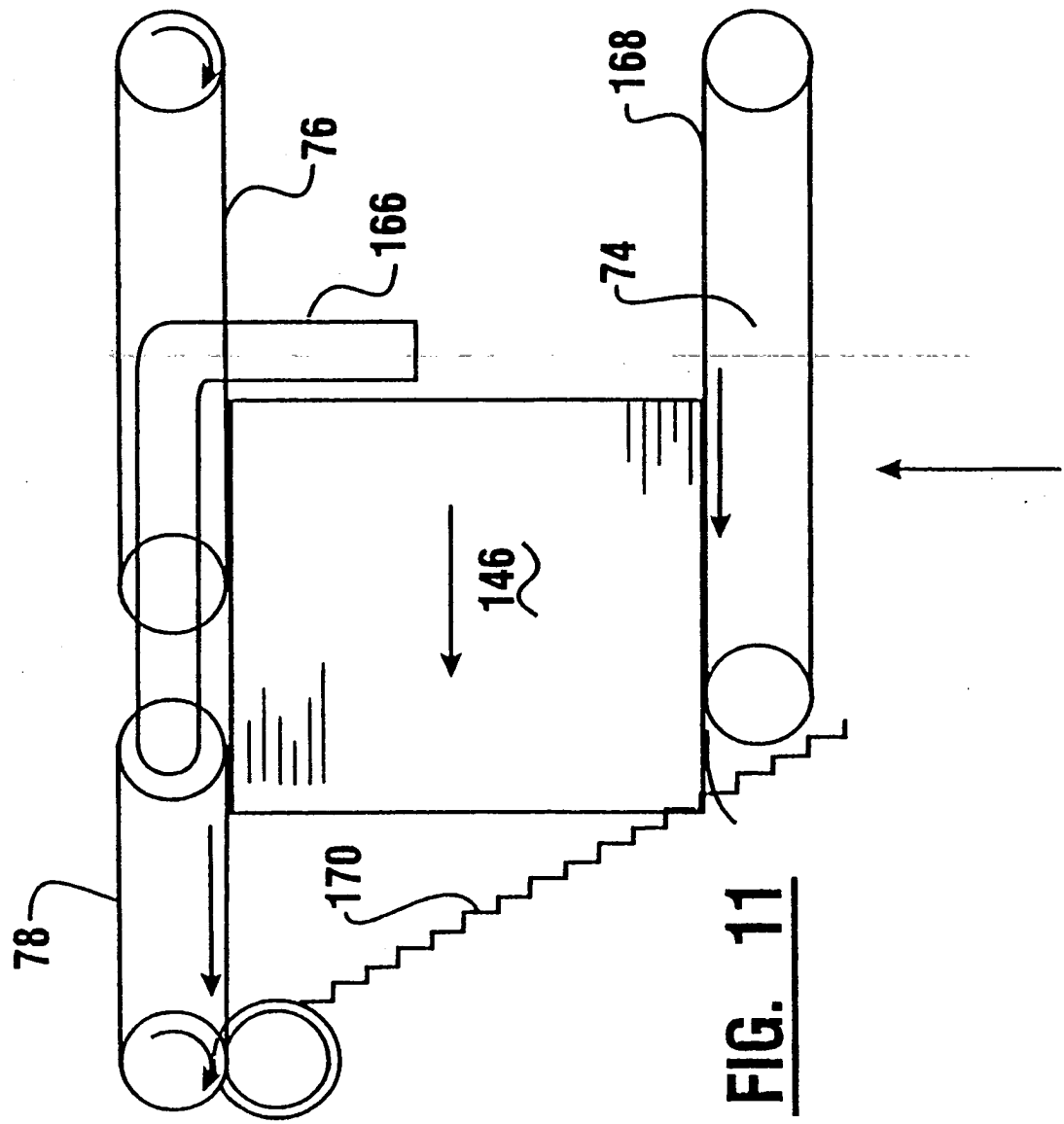




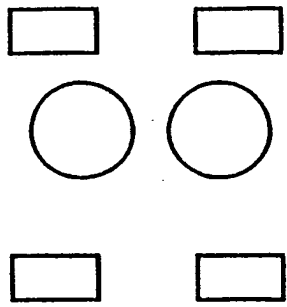
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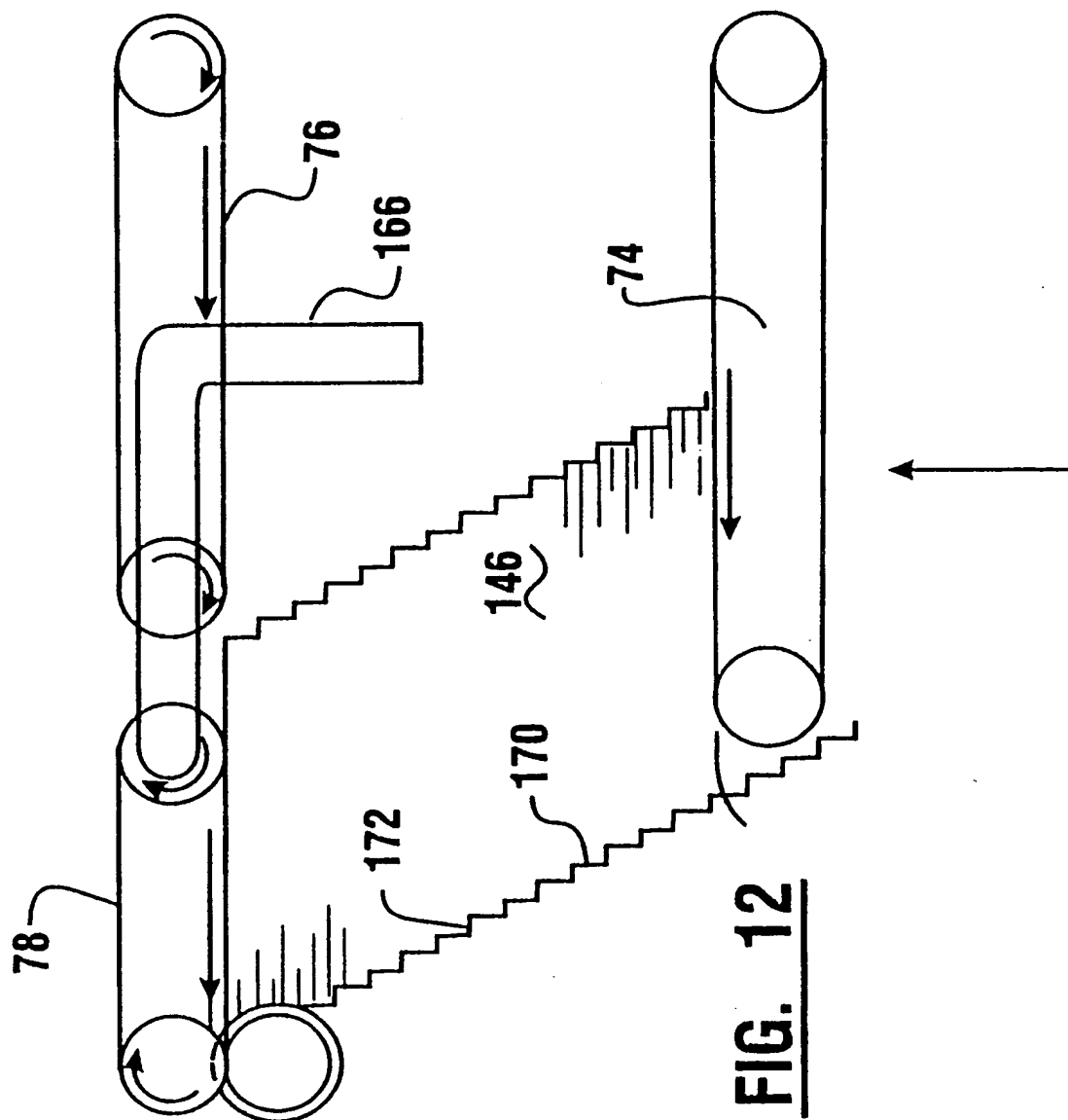
**FIG. 10**

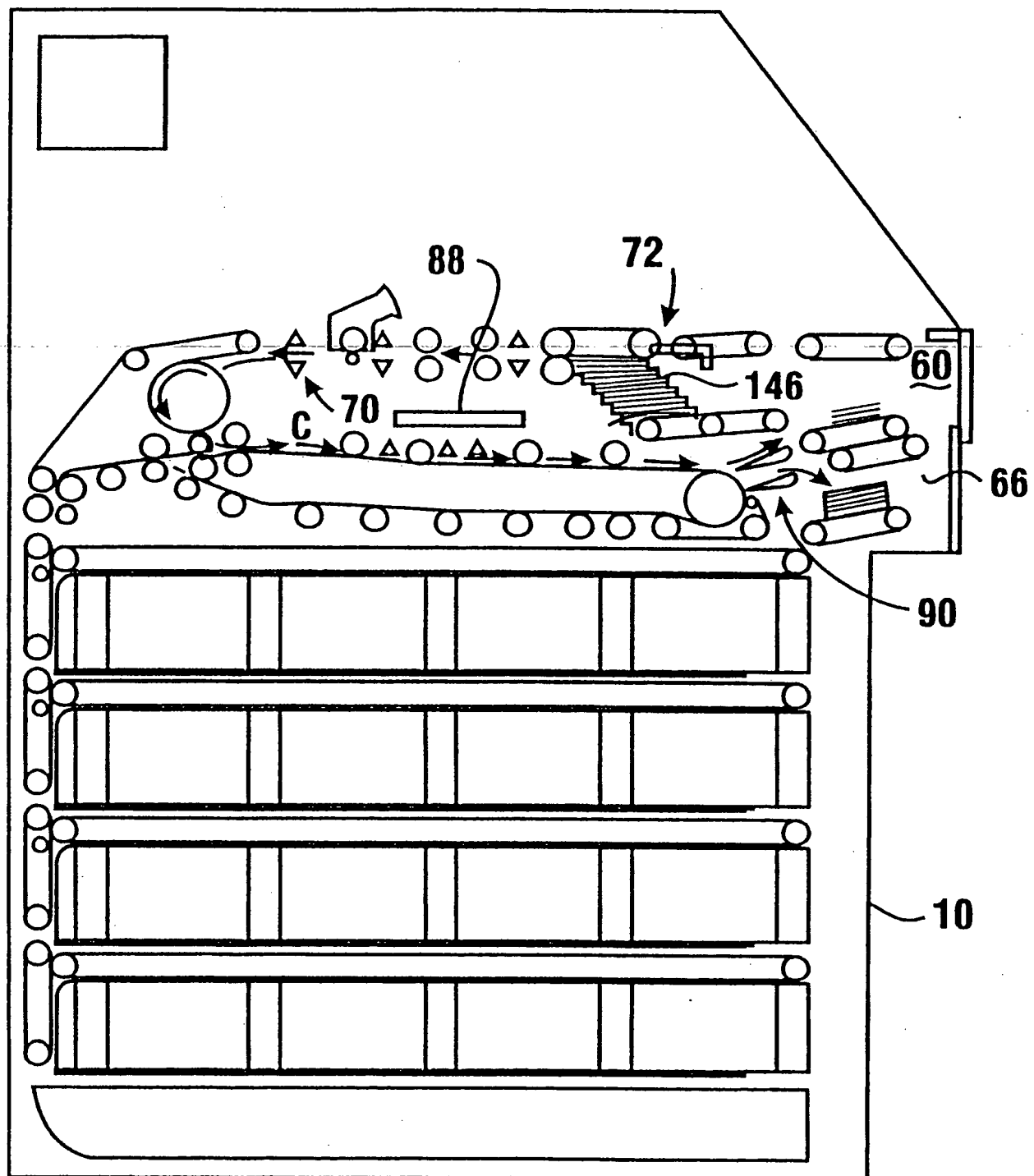


**FIG. 11**

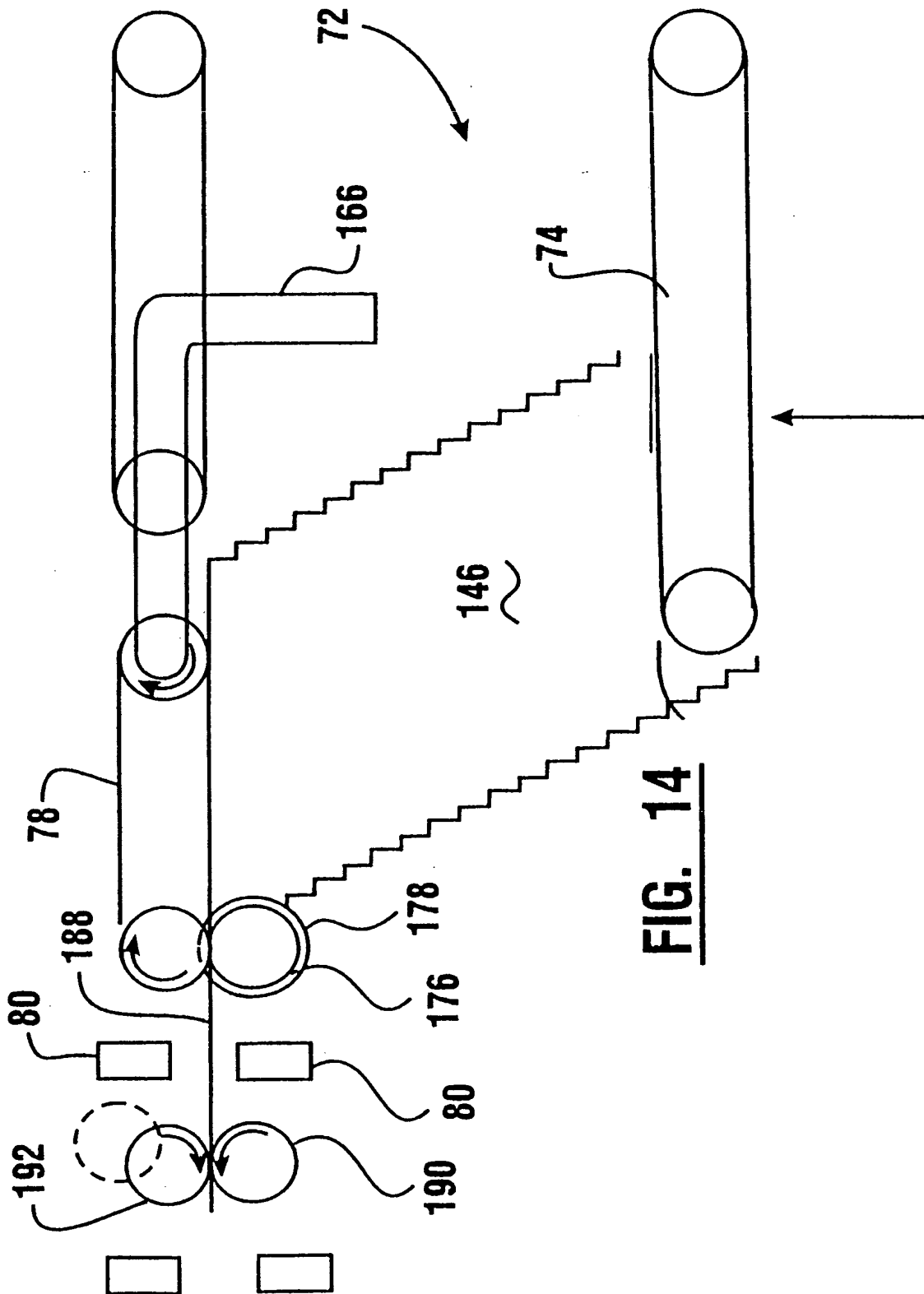


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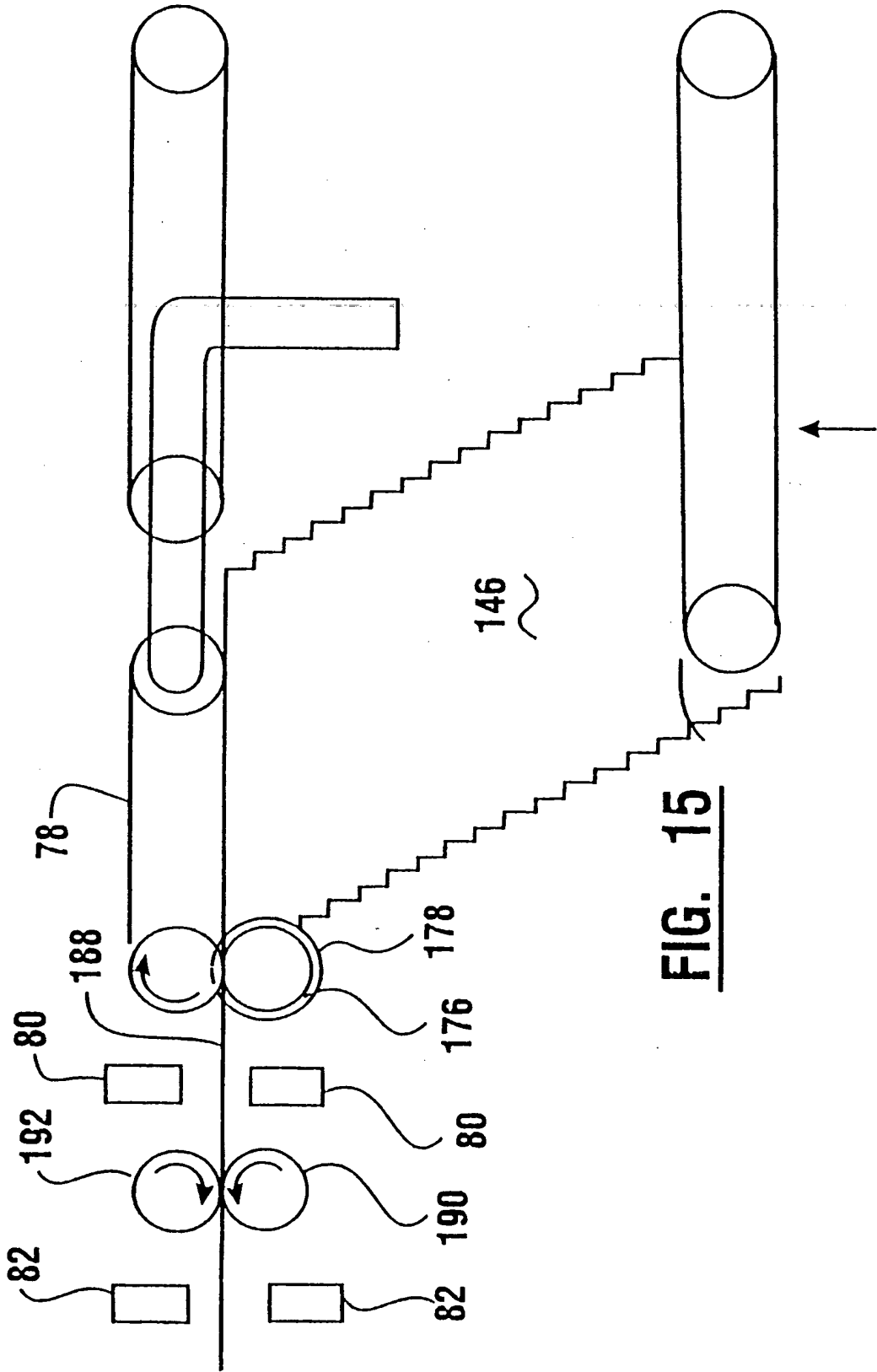


**FIG. 13**

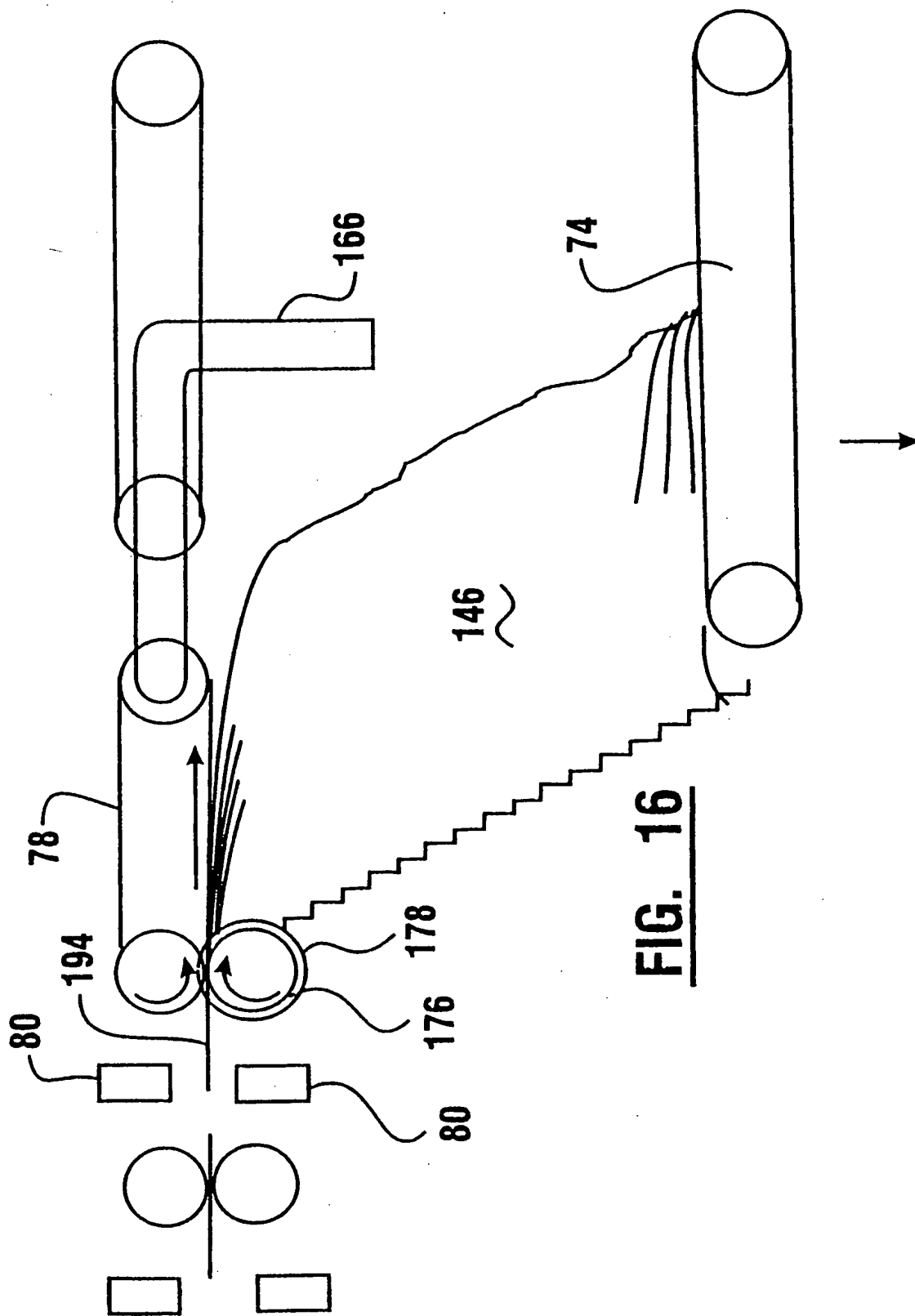
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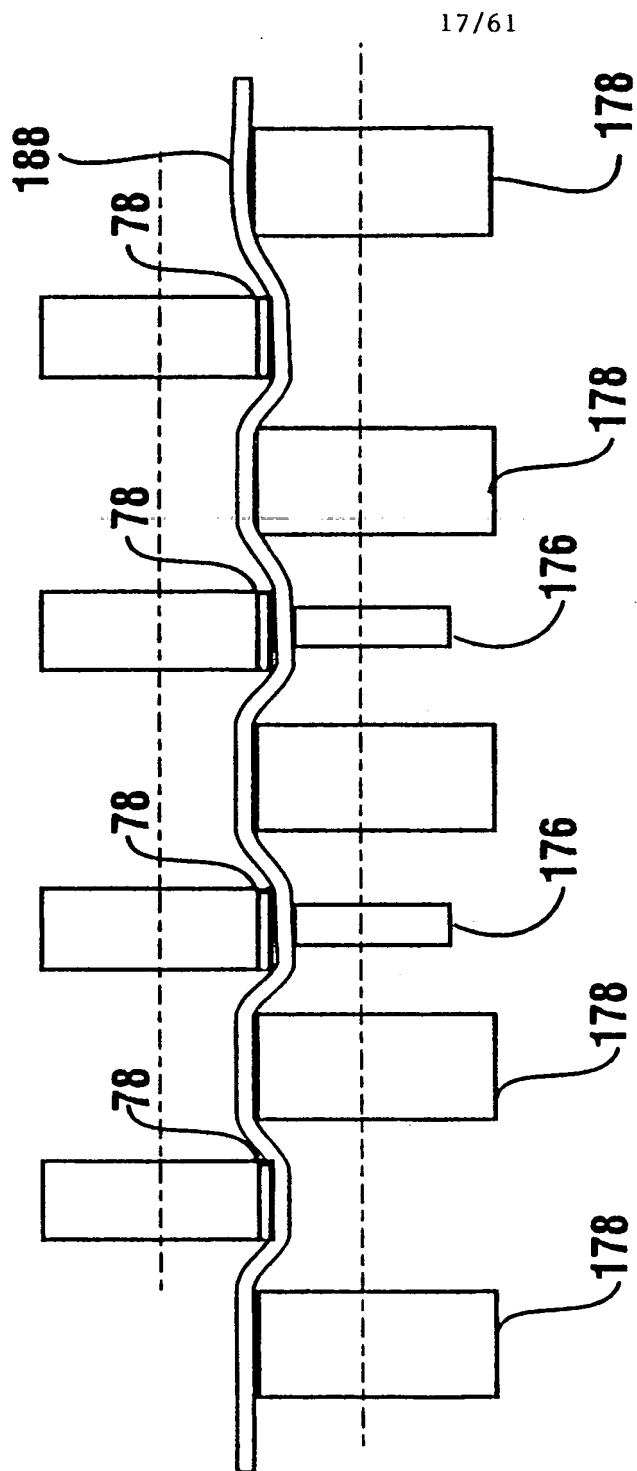


**FIG. 14**



**FIG. 15**

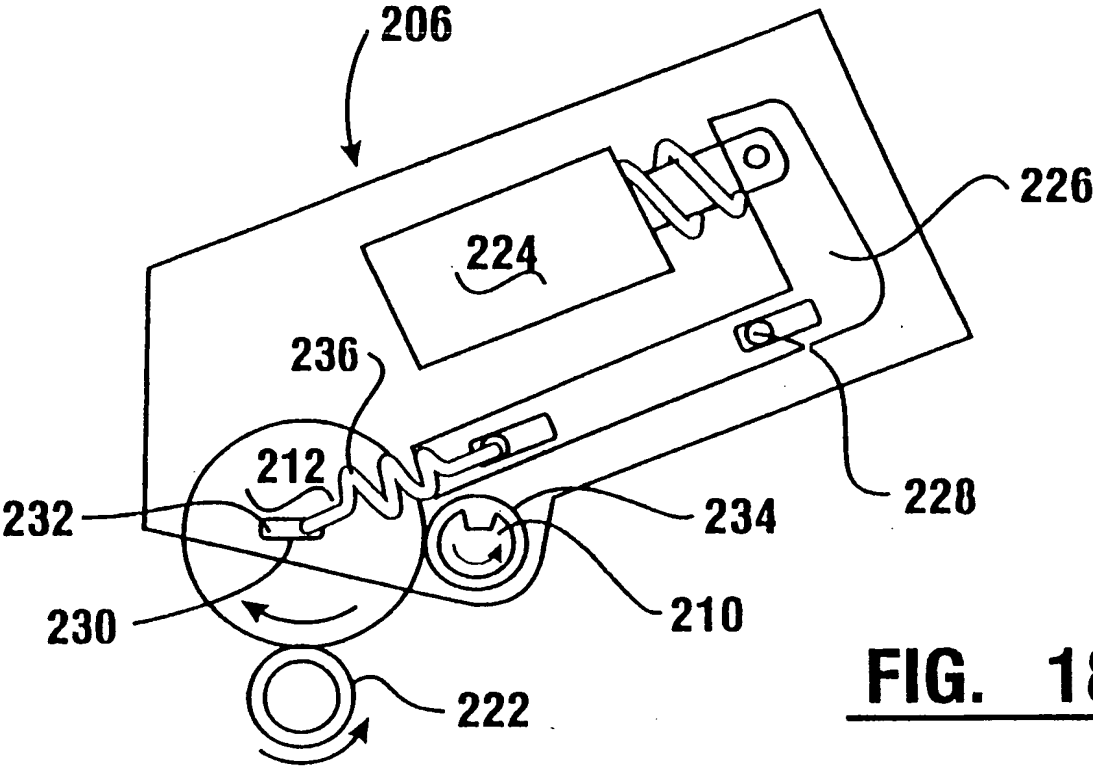




**FIG. 17**

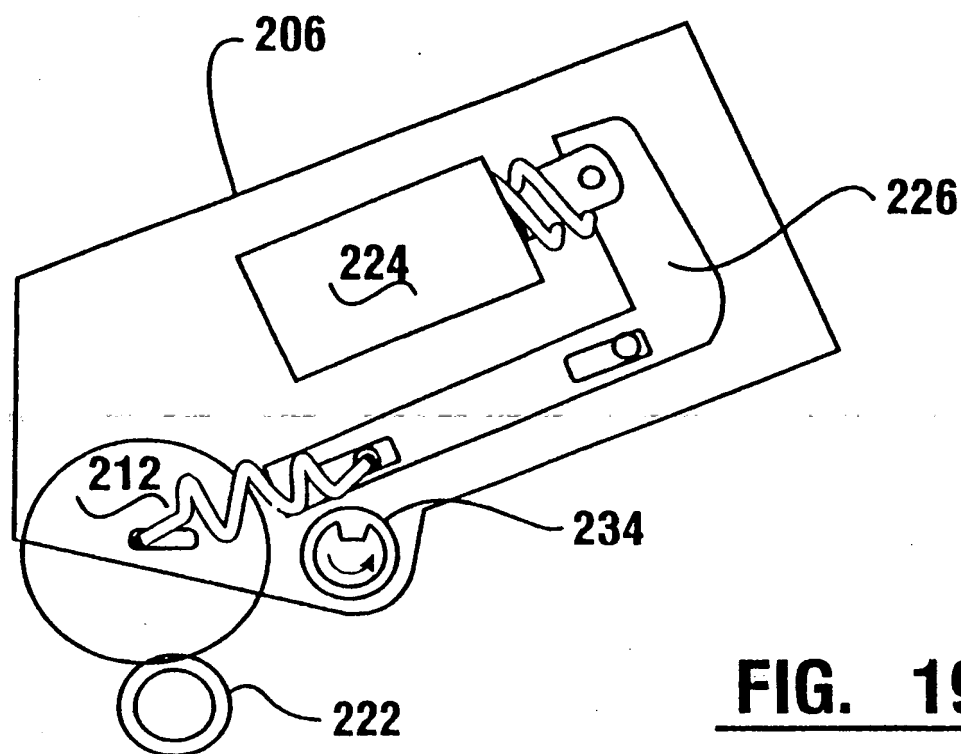


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**FIG. 18**

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**FIG. 19**

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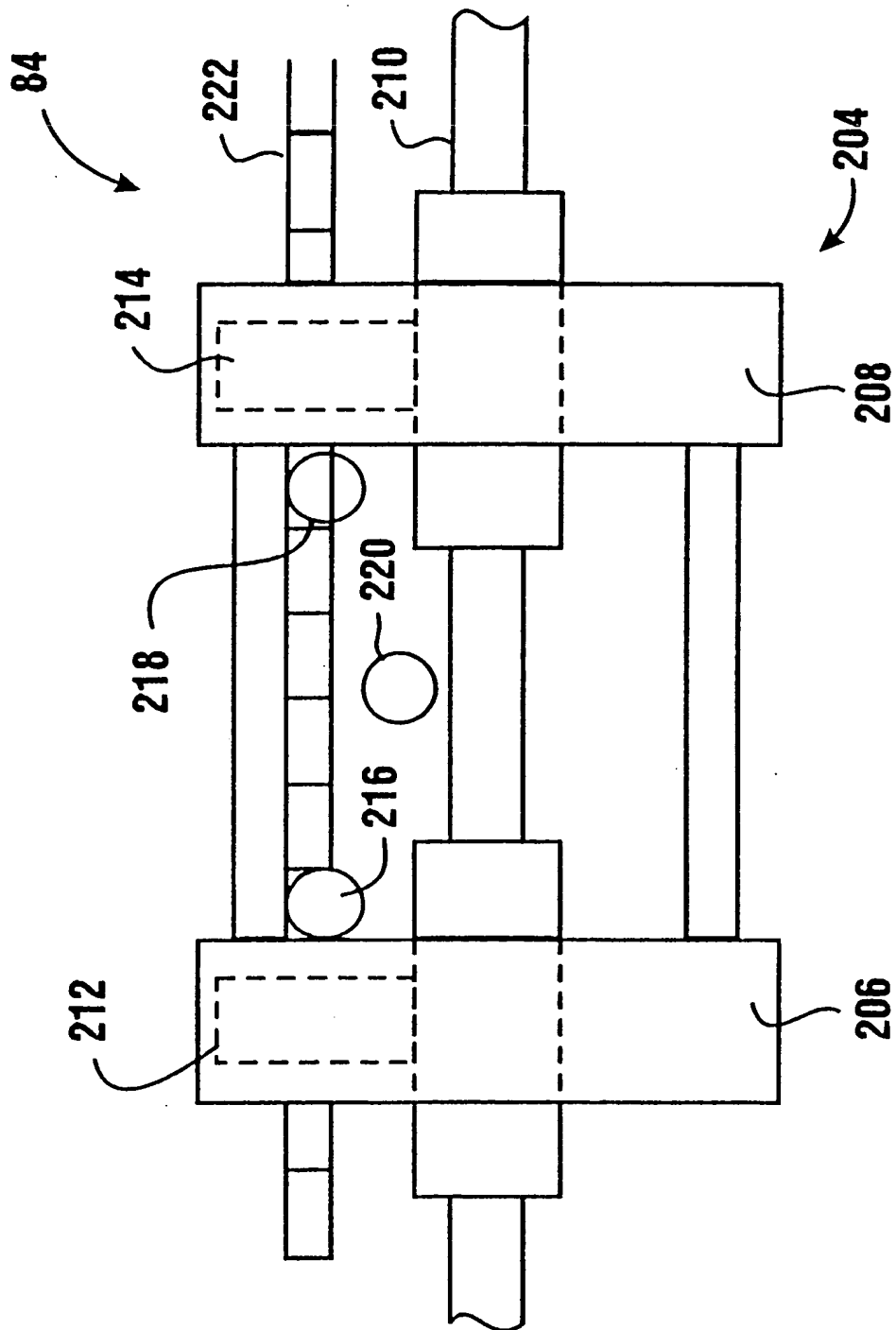
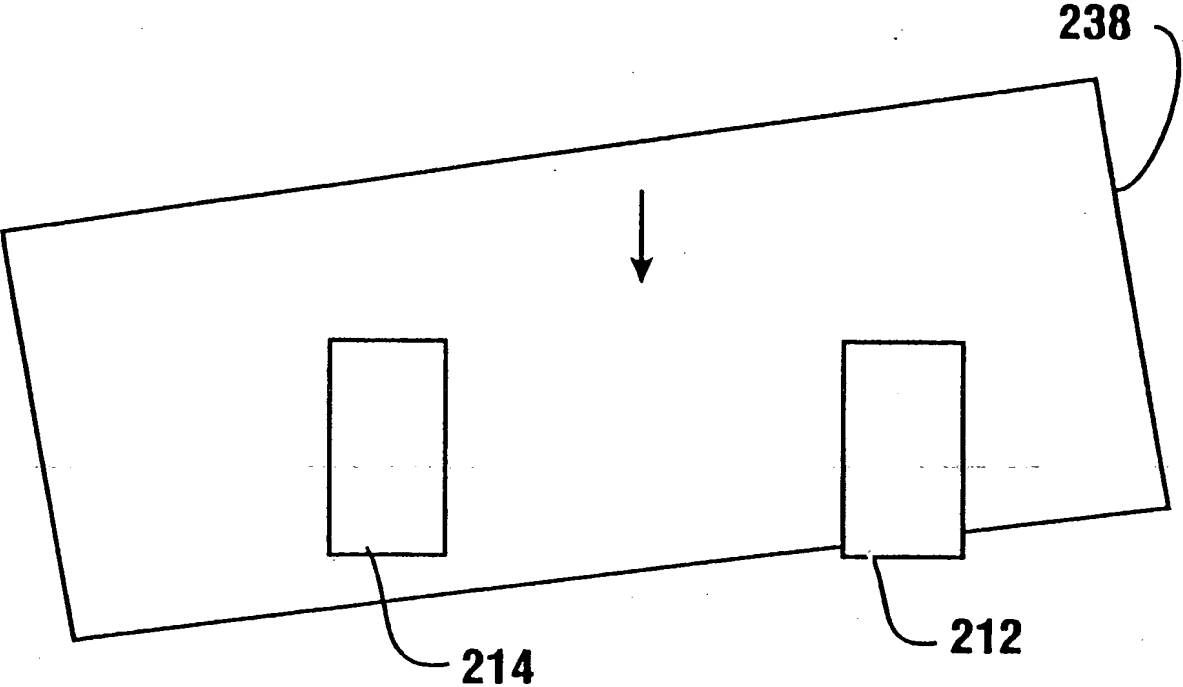
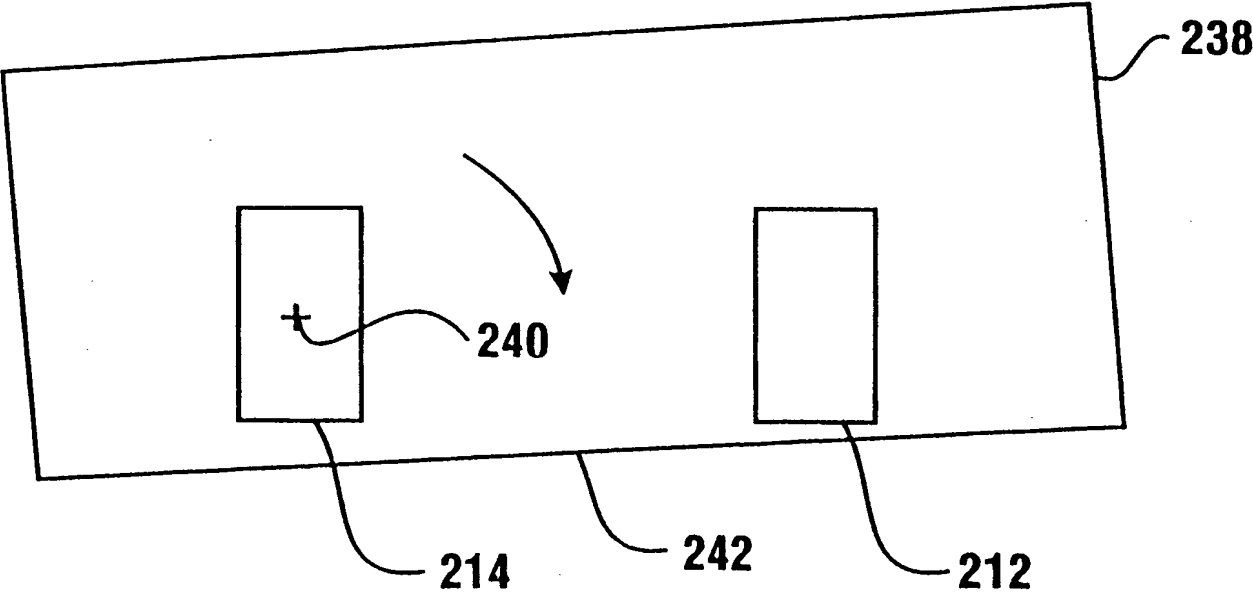


FIG. 20

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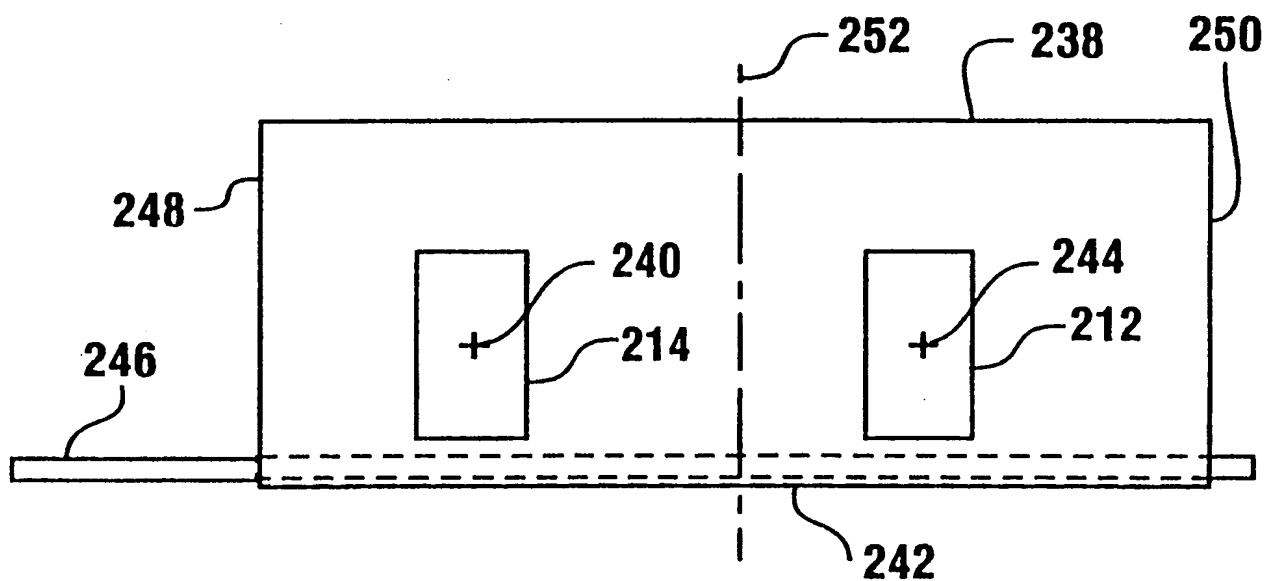
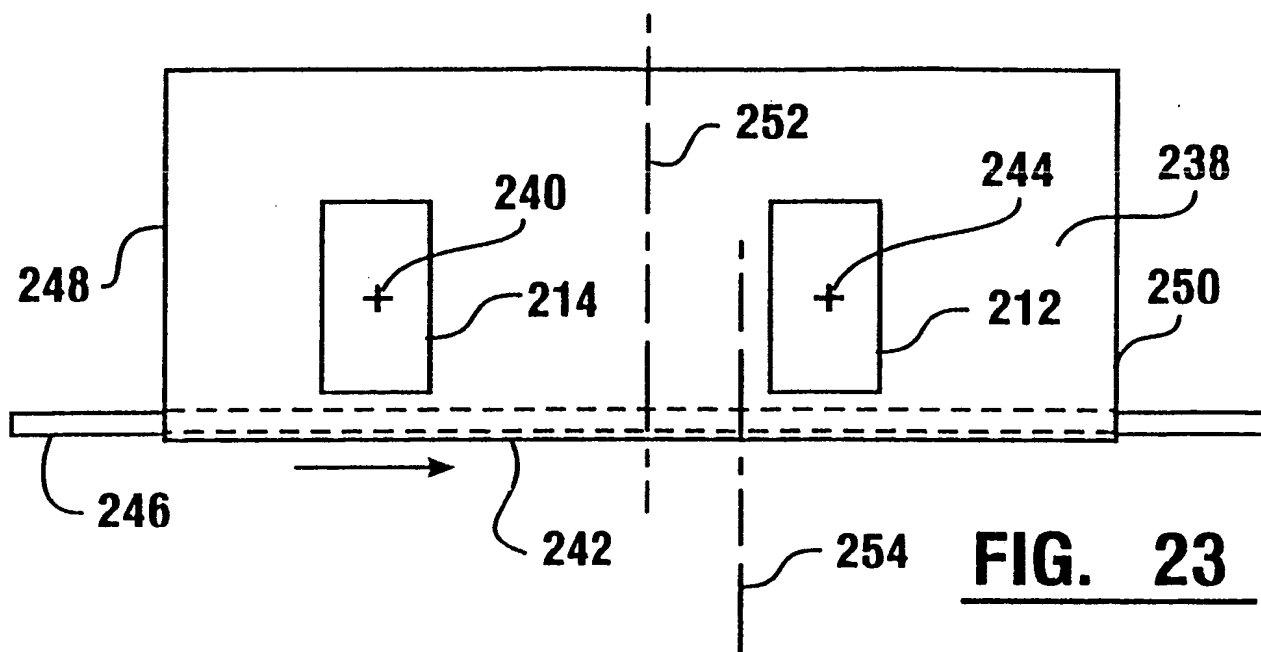


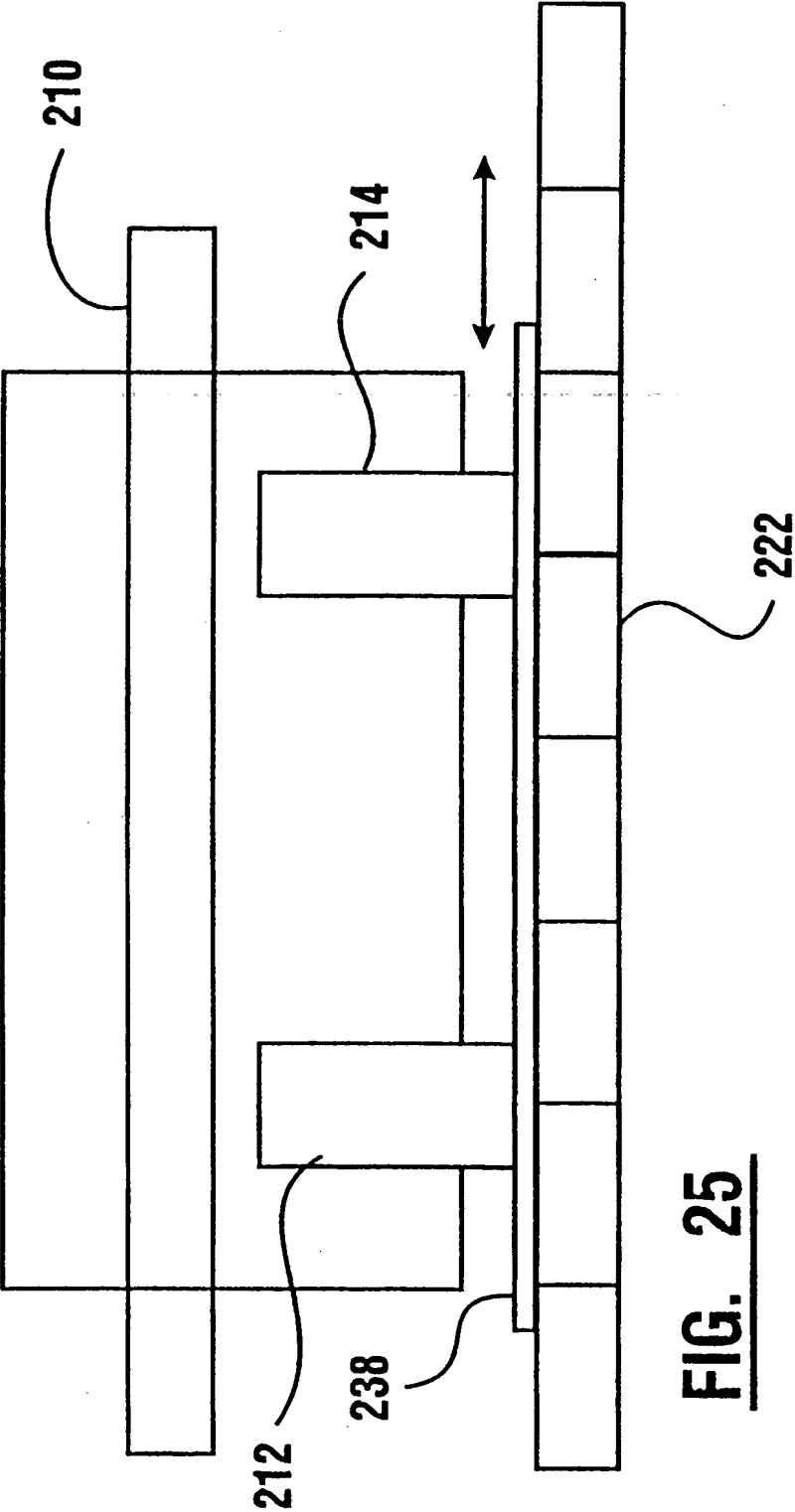
**FIG. 21**



**FIG. 22**

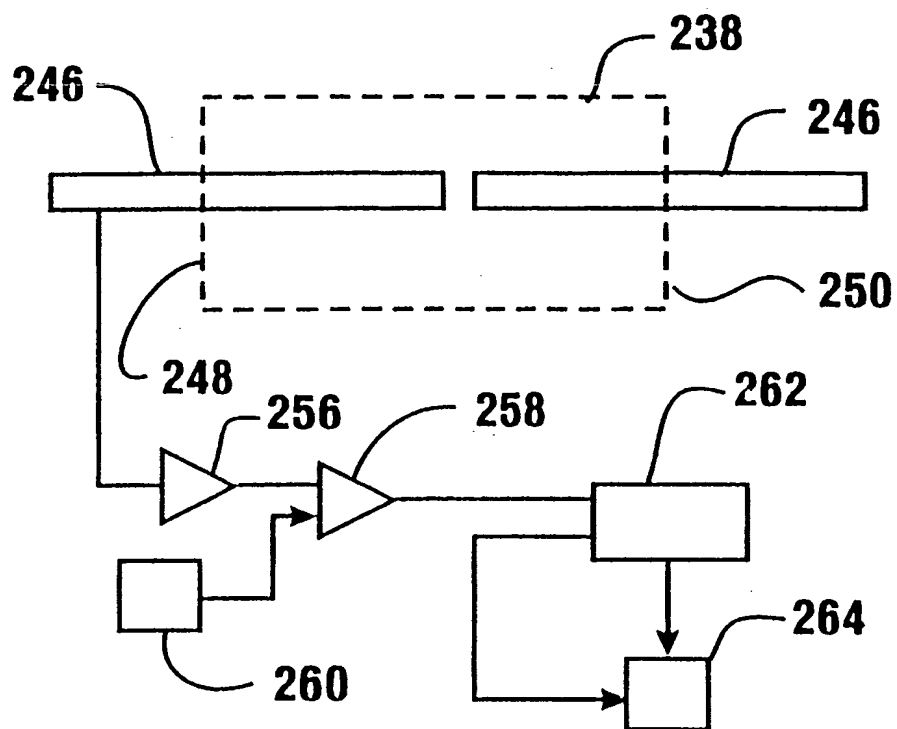
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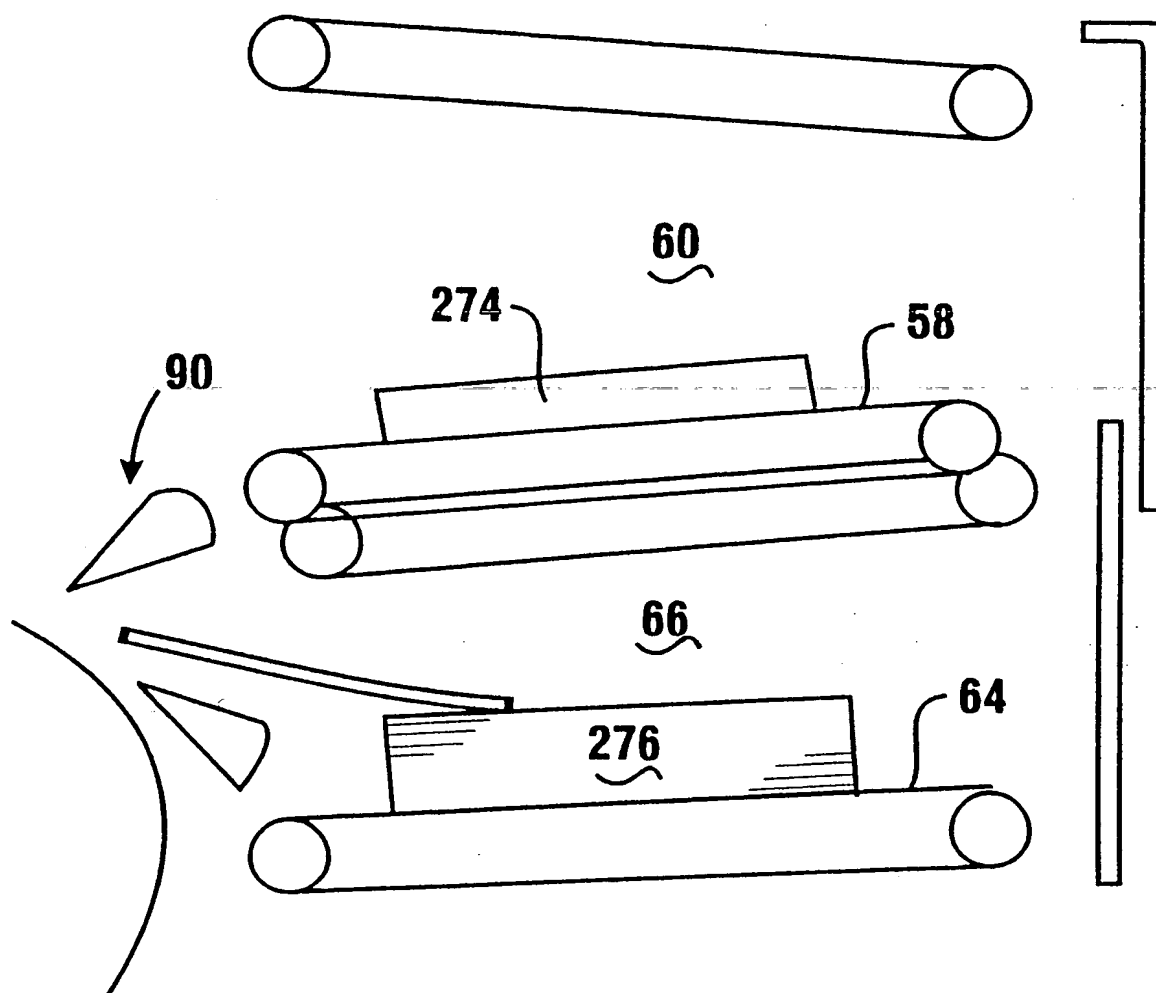


**FIG. 25**

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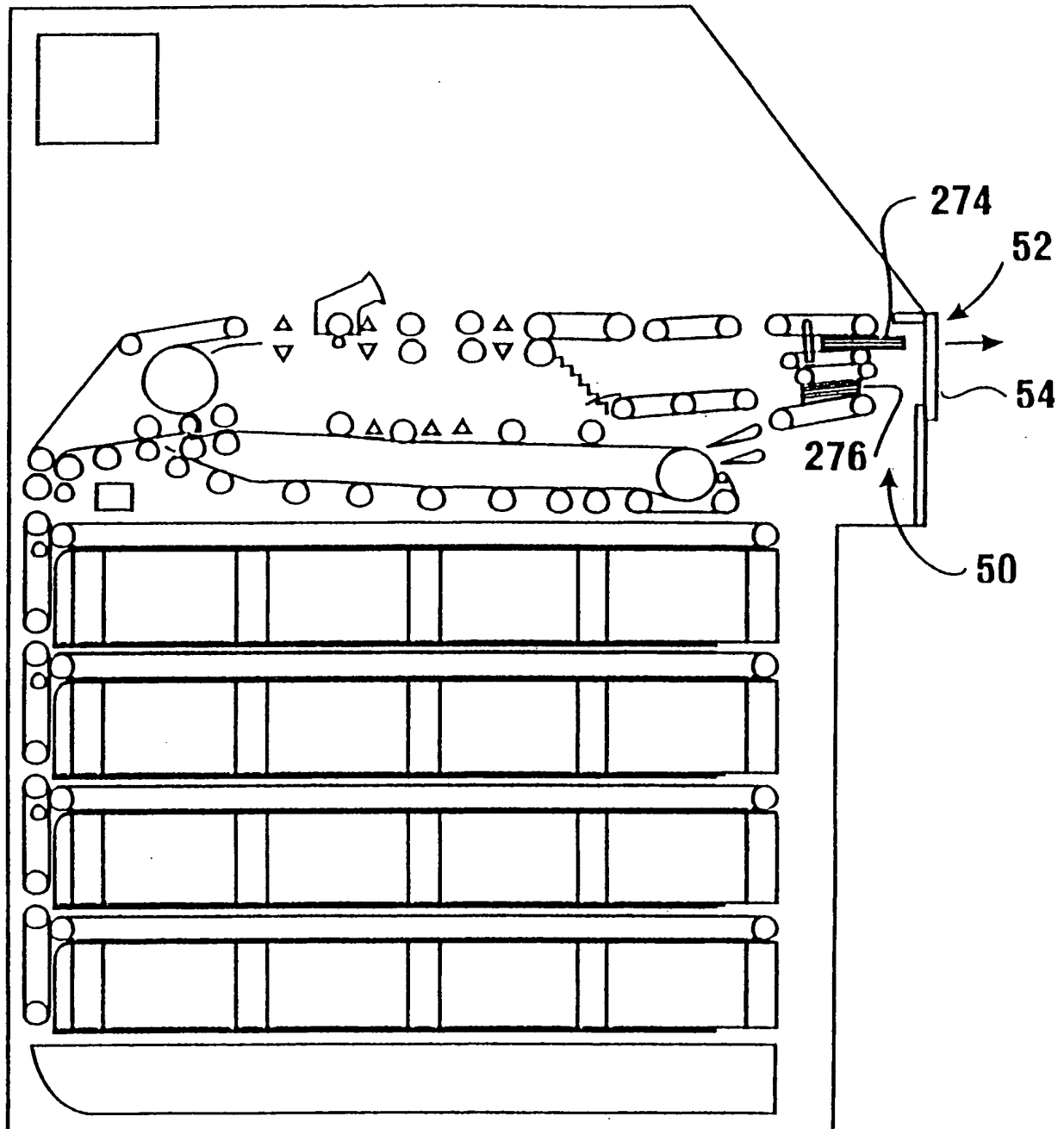
**FIG. 26**

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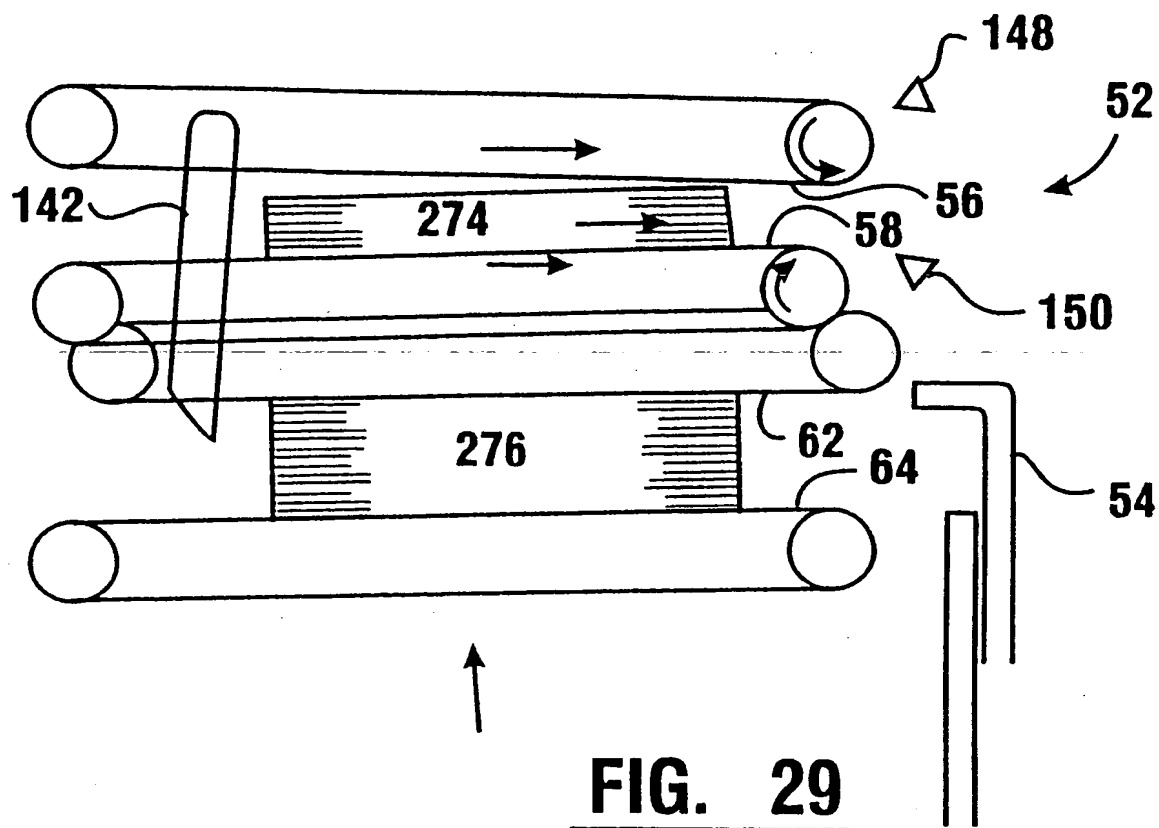
**FIG. 27**



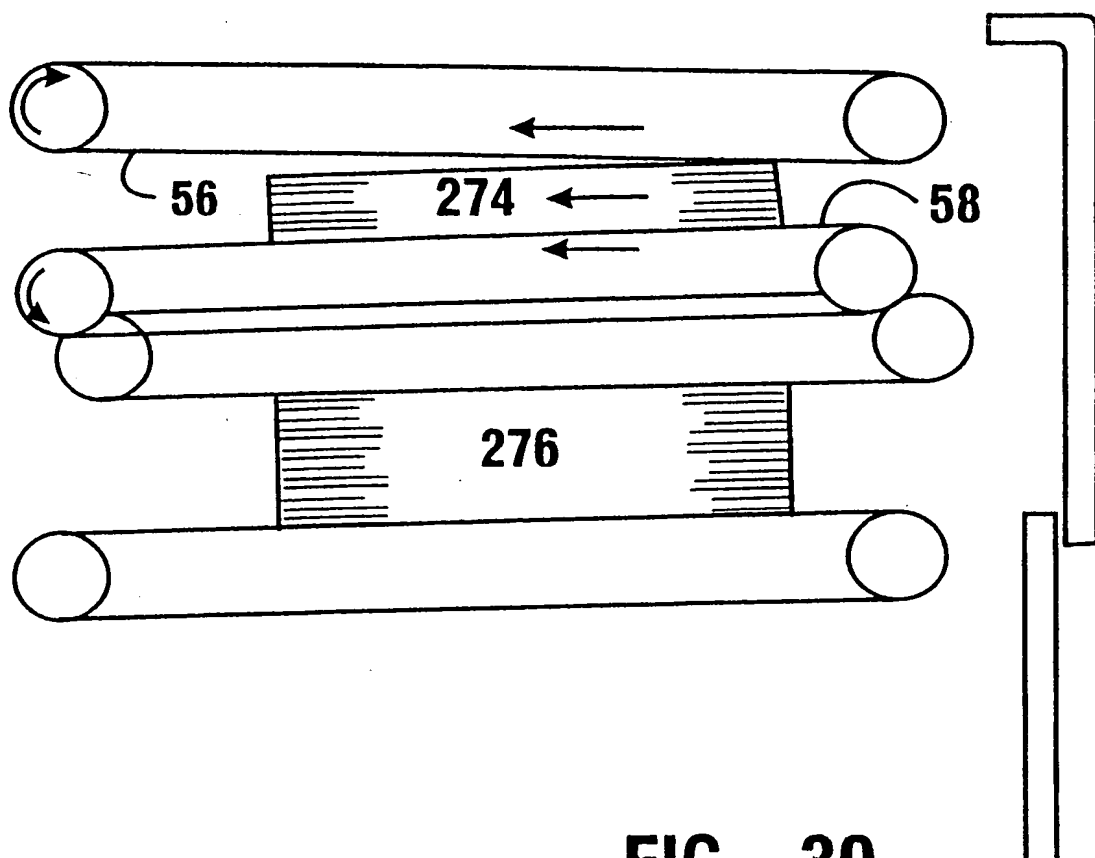


**FIG. 28**

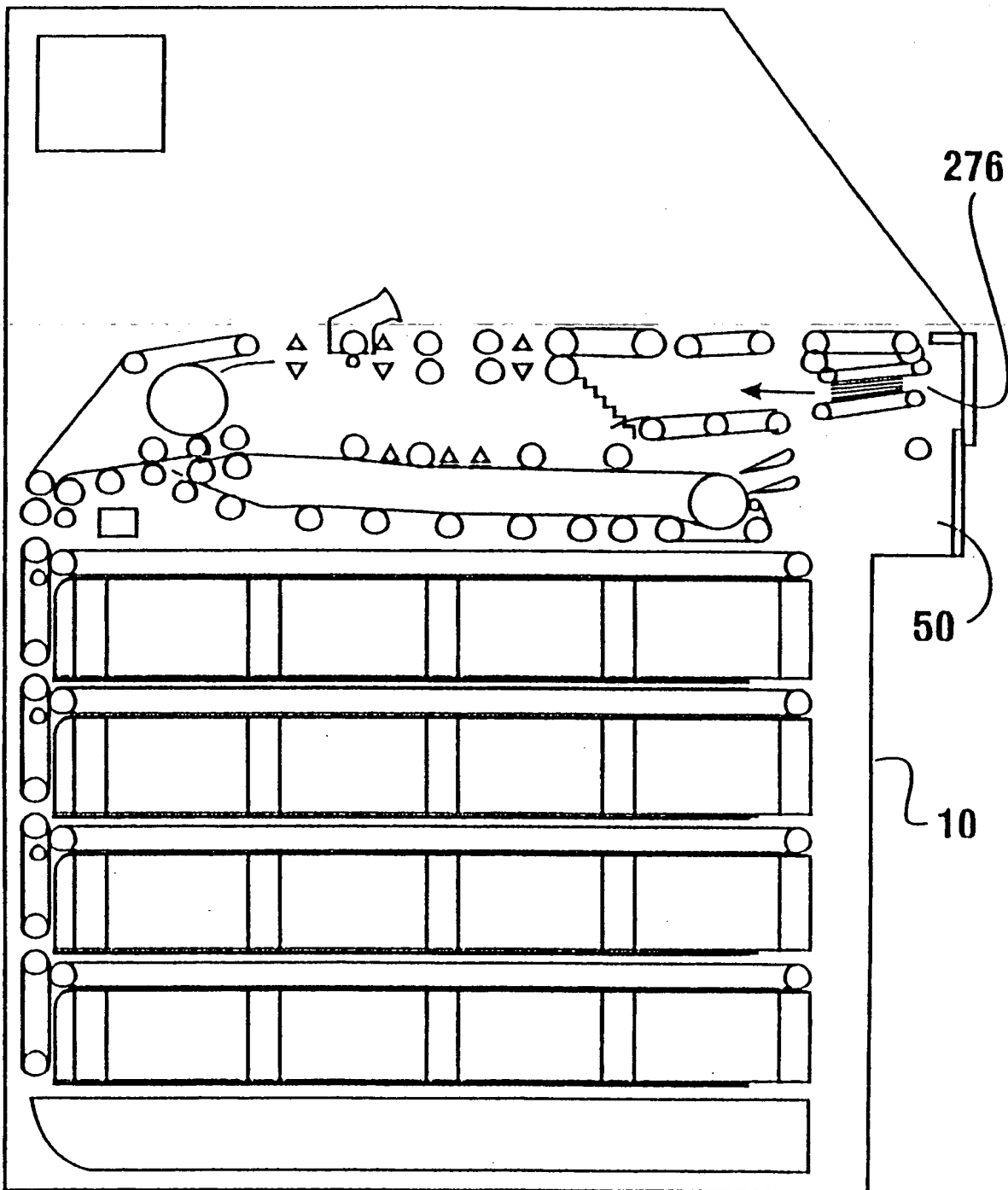
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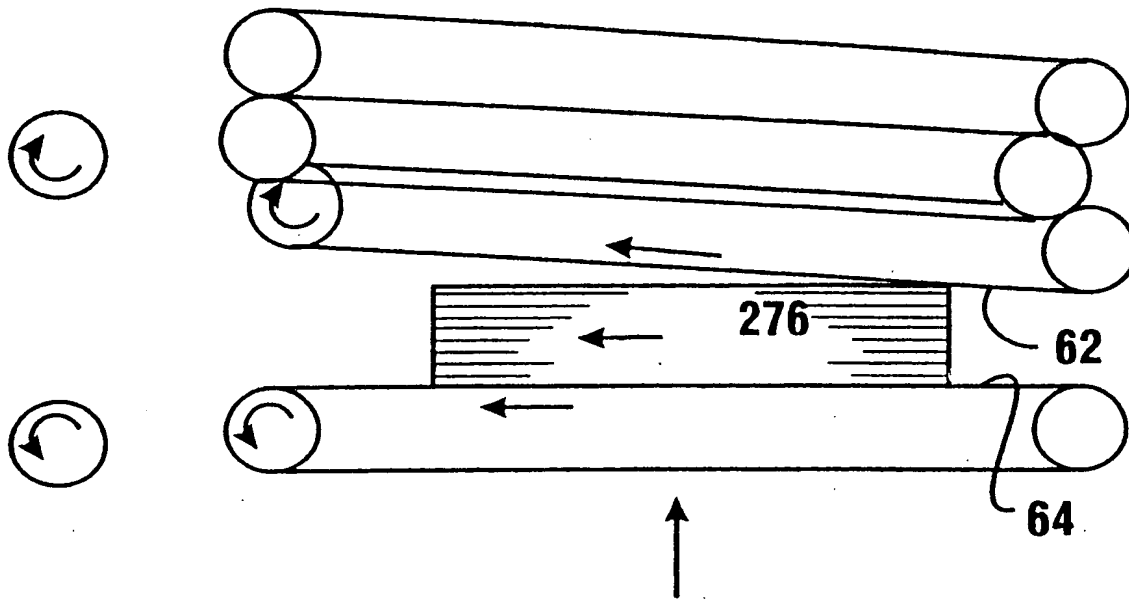


**FIG. 30**



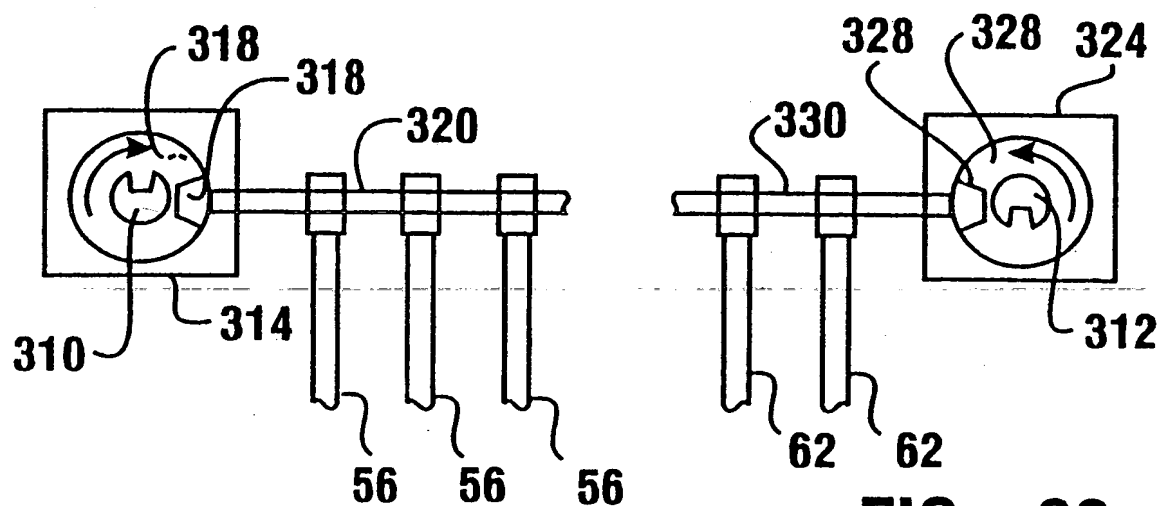
**FIG. 31**

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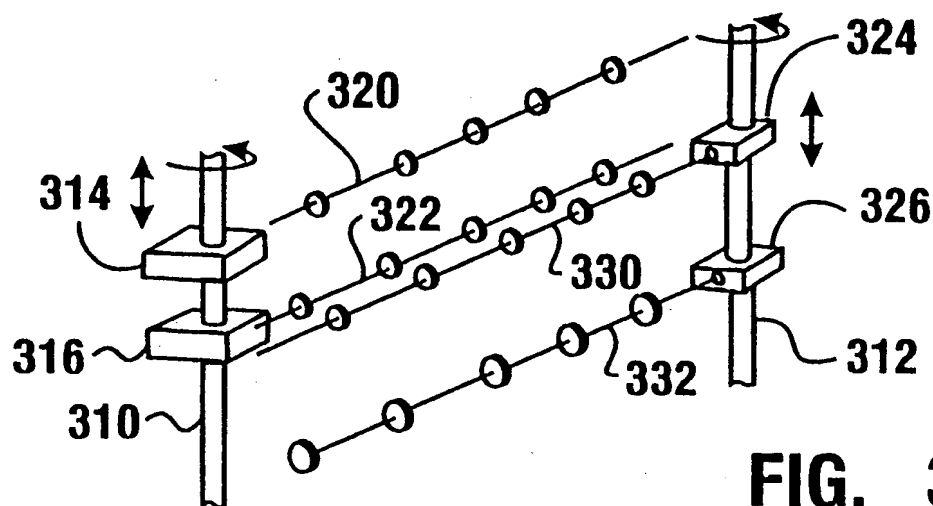


**FIG. 32**

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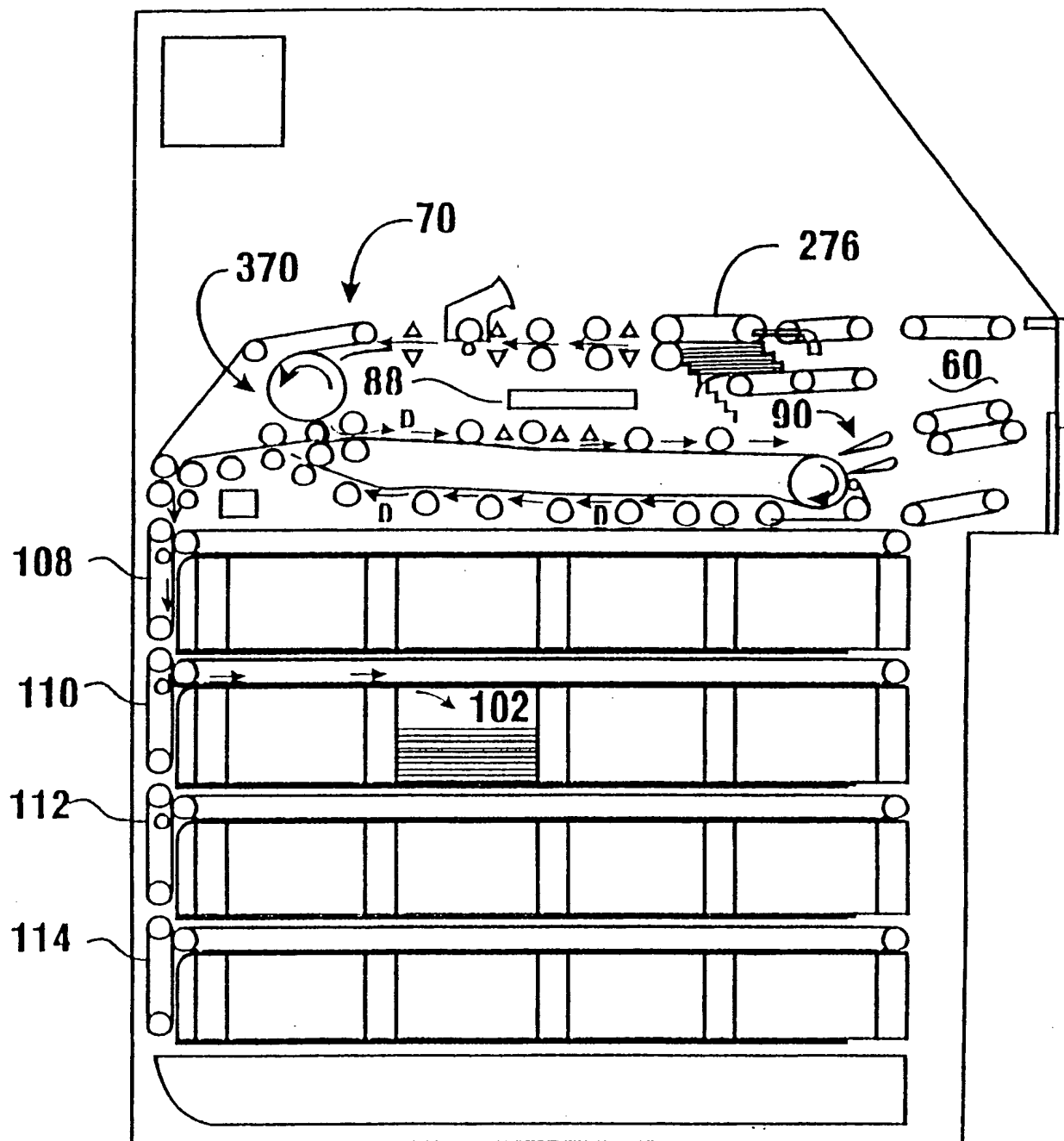


**FIG. 33**

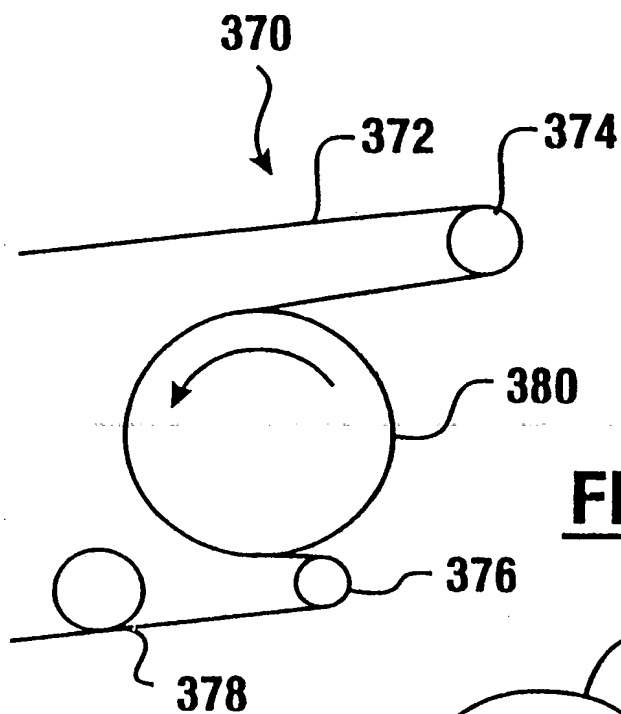


**FIG. 34**

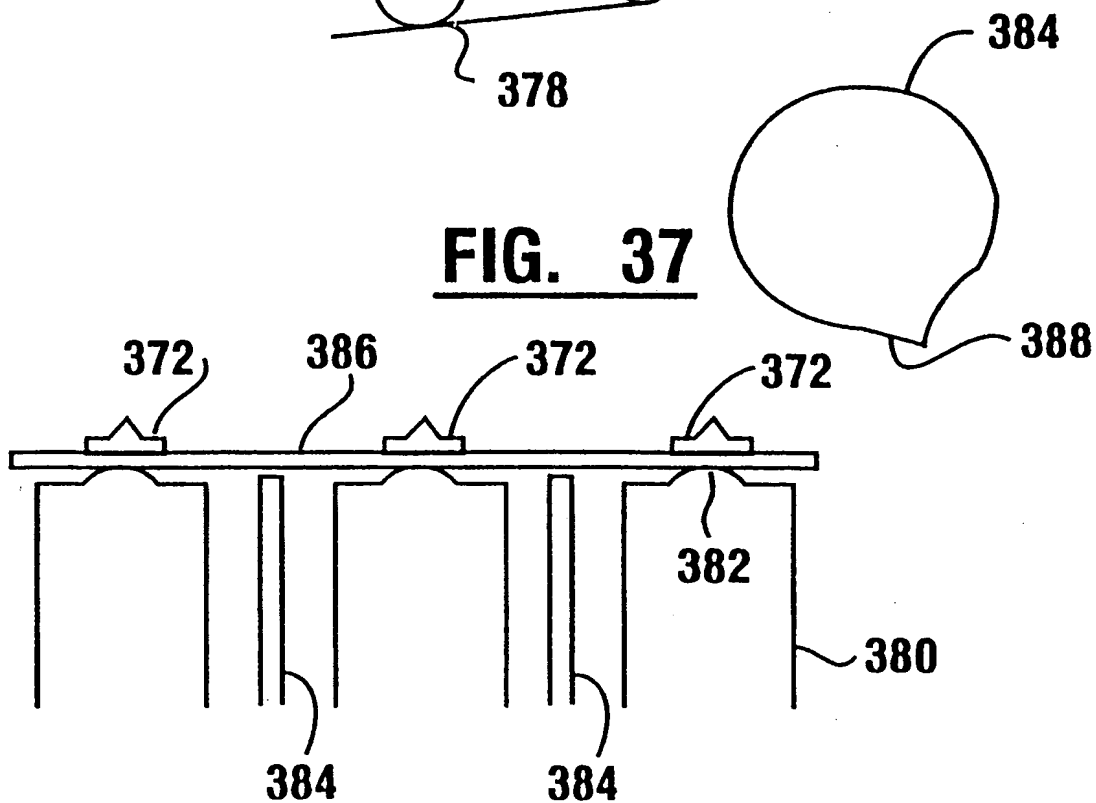
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**FIG. 35**

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**FIG. 36**

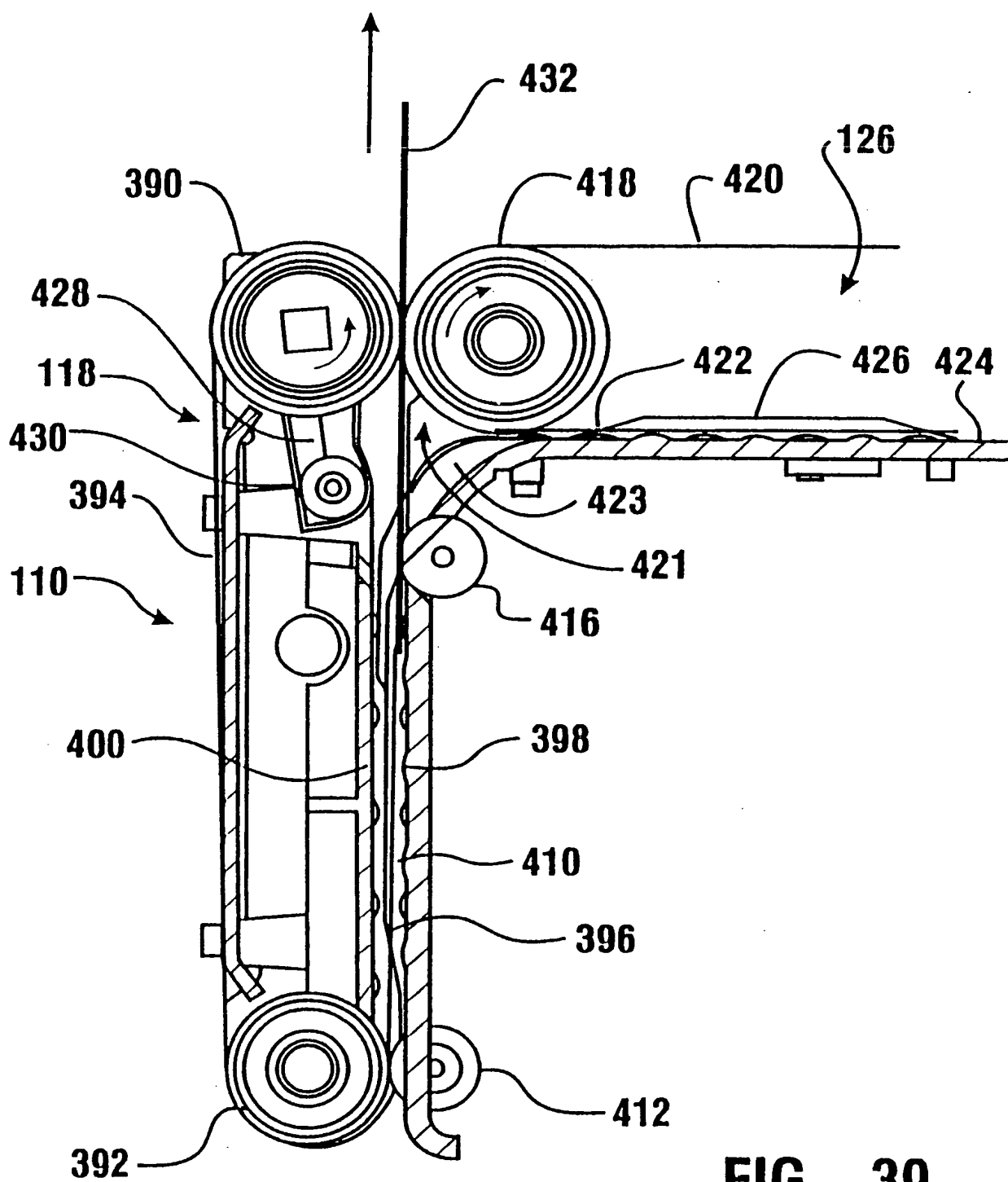


**FIG. 37**

**FIG. 38**

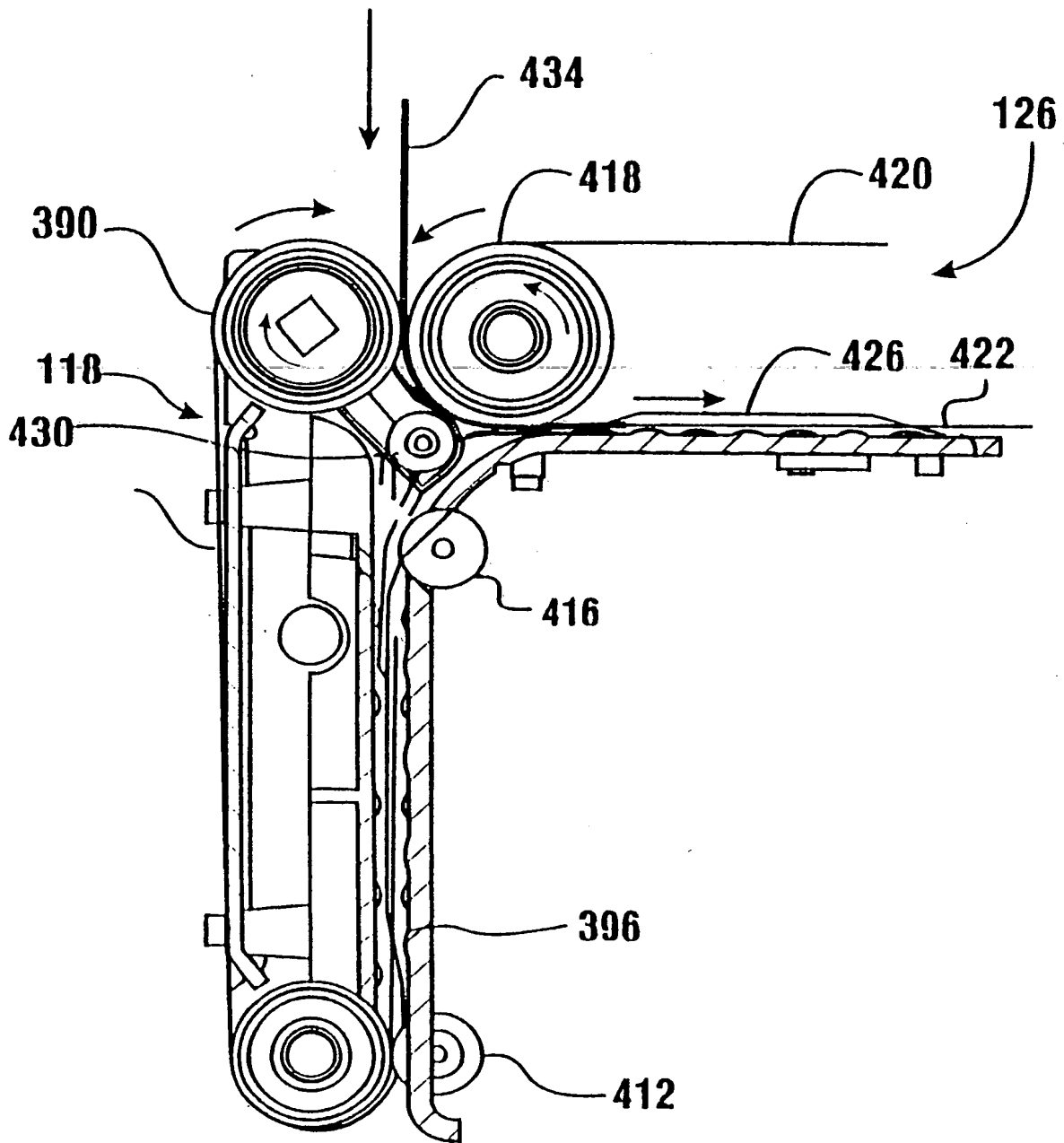


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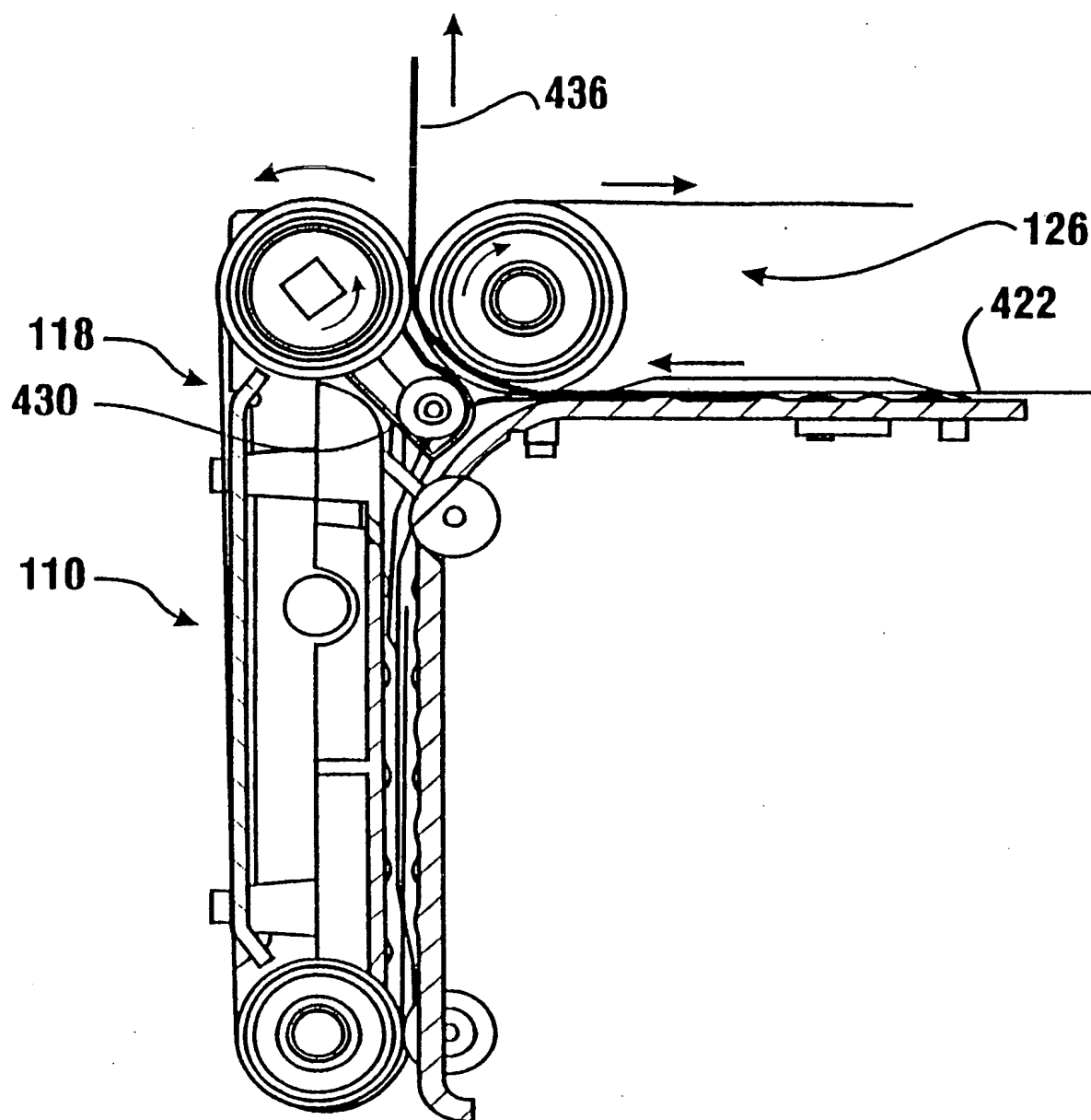
**FIG. 39**

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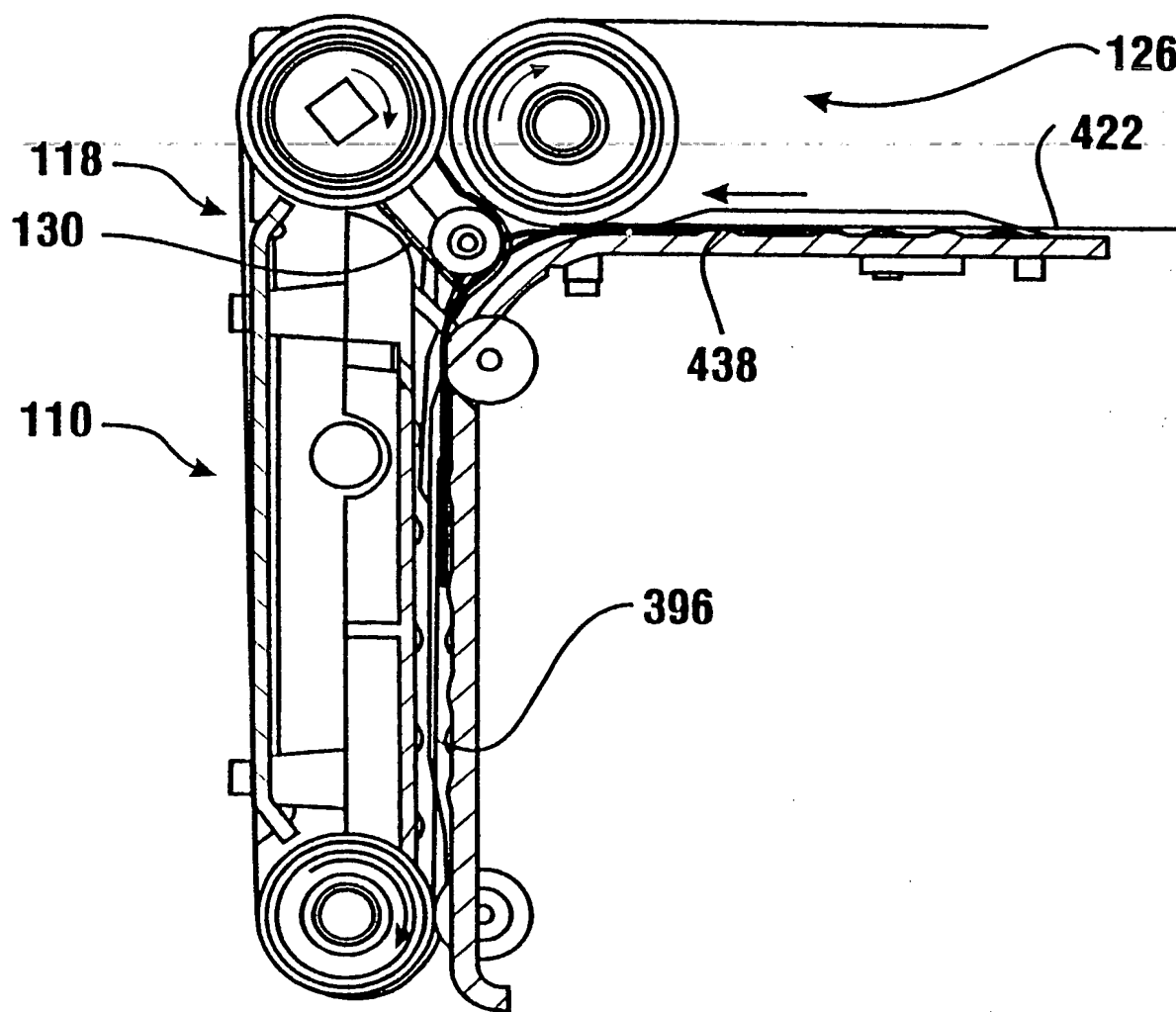
**FIG. 40**

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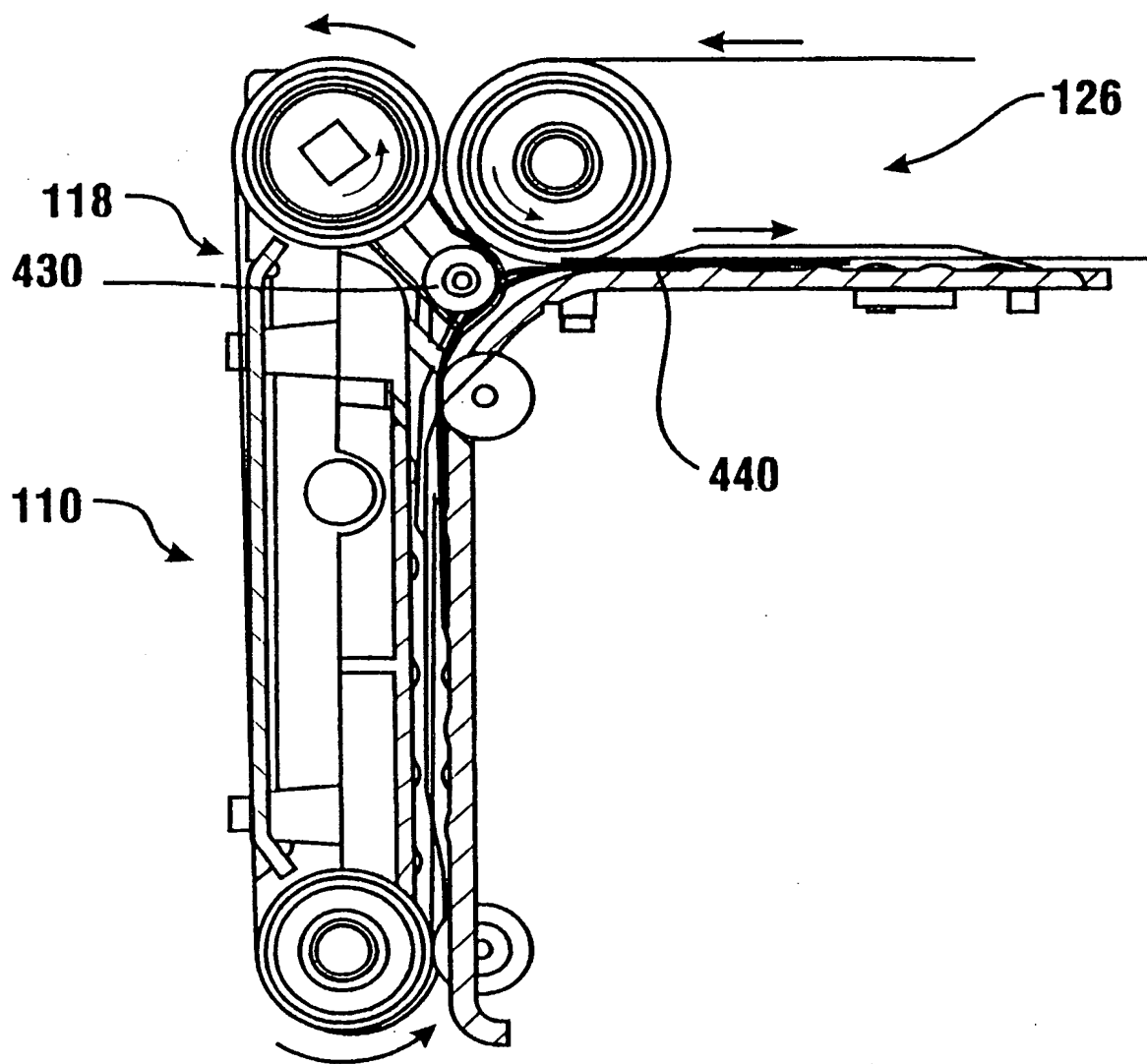


**FIG. 41**

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**FIG. 42**



**FIG. 43**

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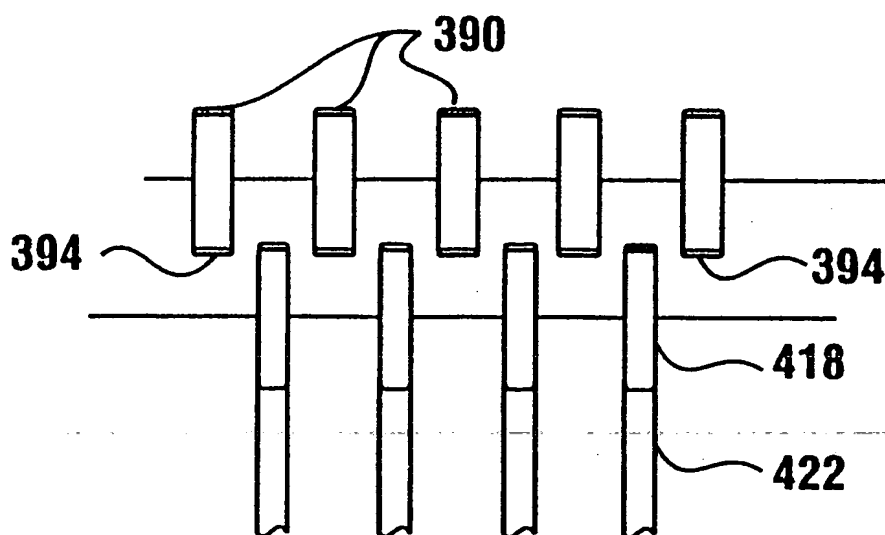
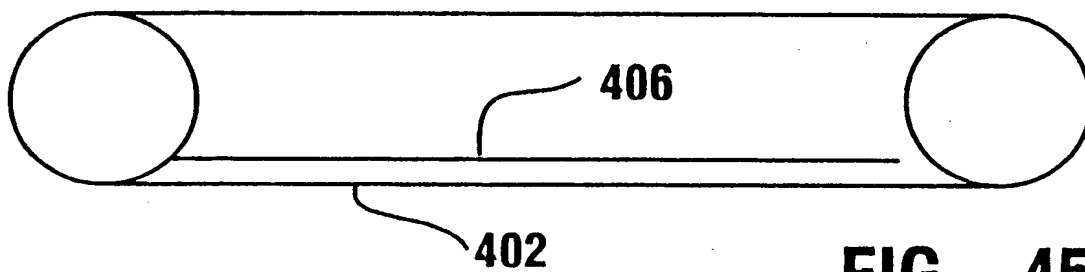
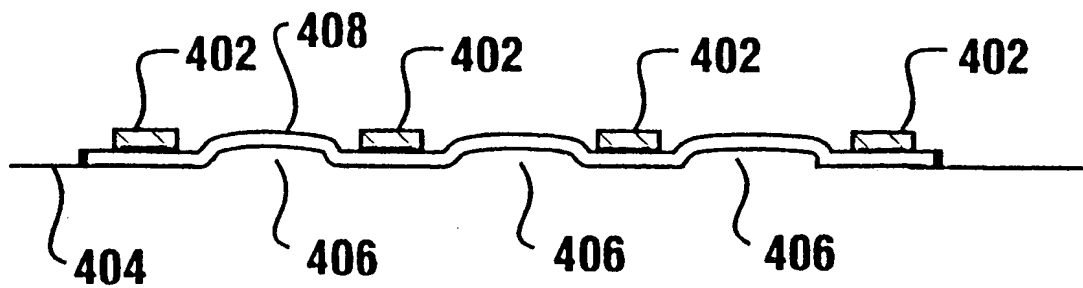


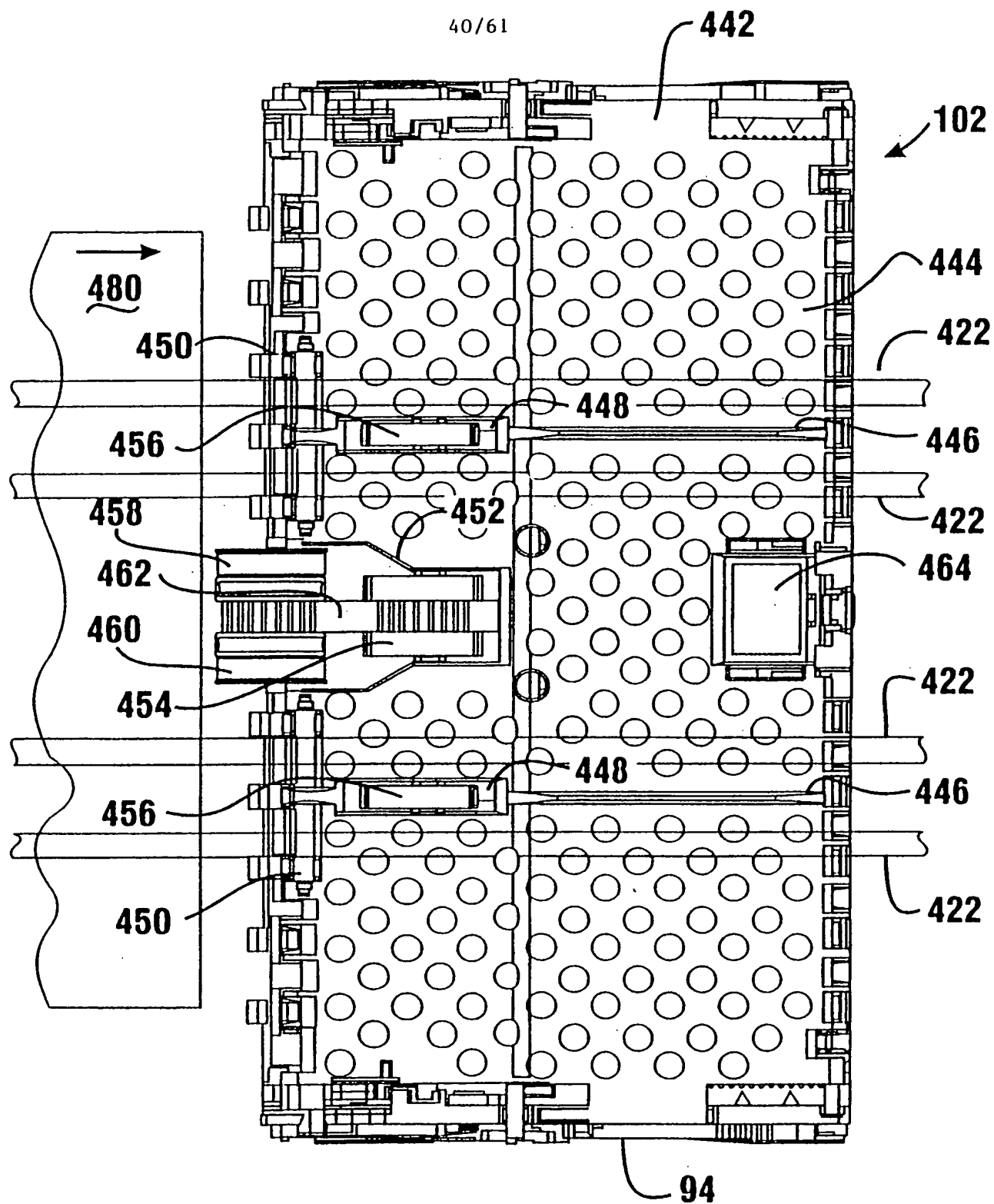
FIG. 44



**FIG. 45**

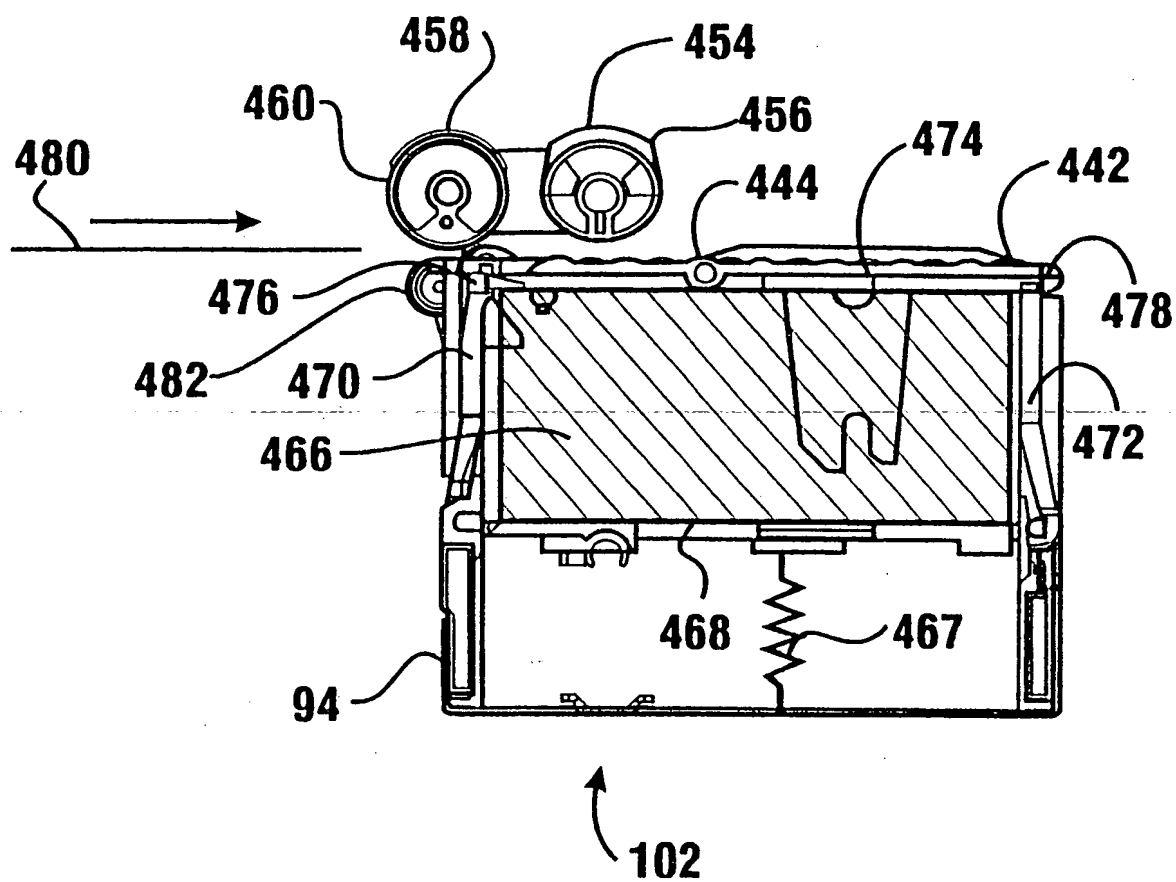


**FIG. 46**



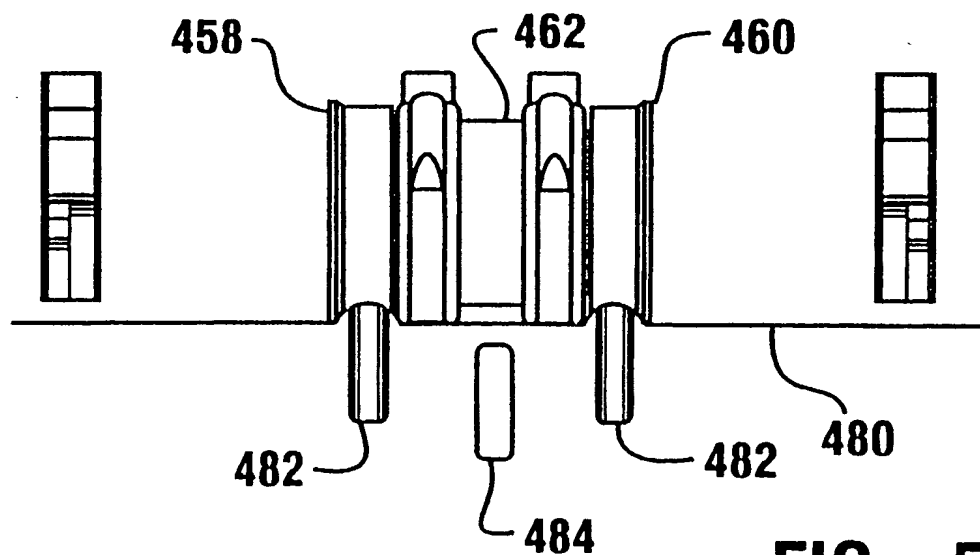
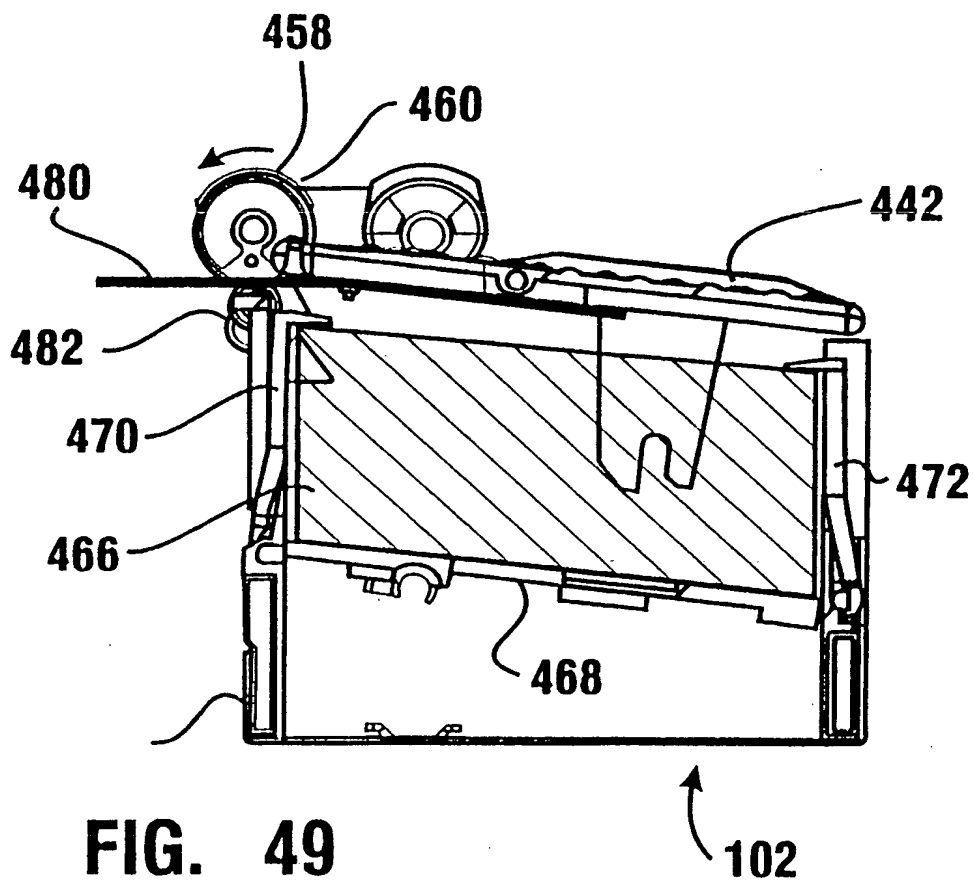
**FIG. 47**

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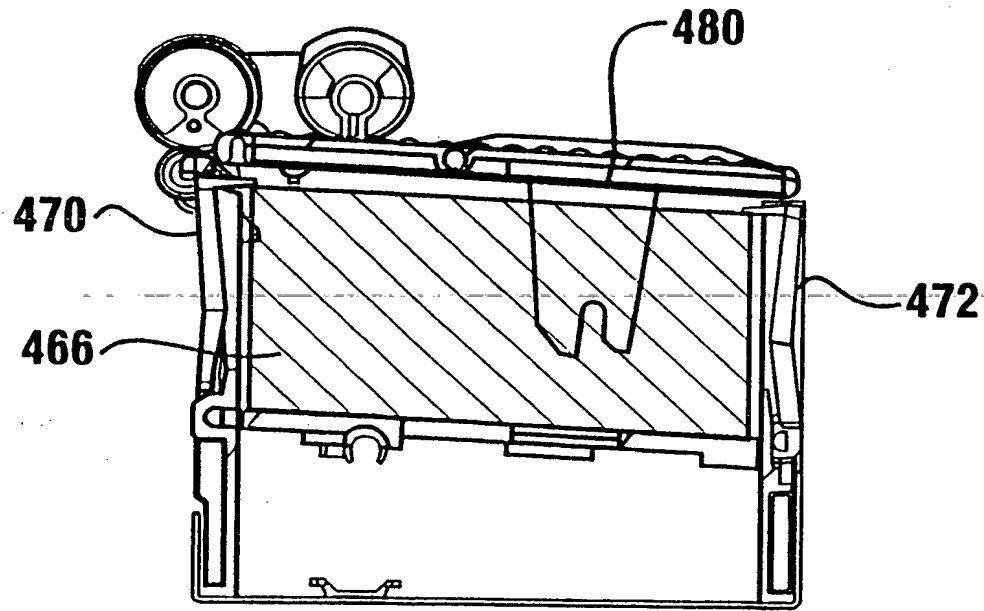
**FIG. 48**



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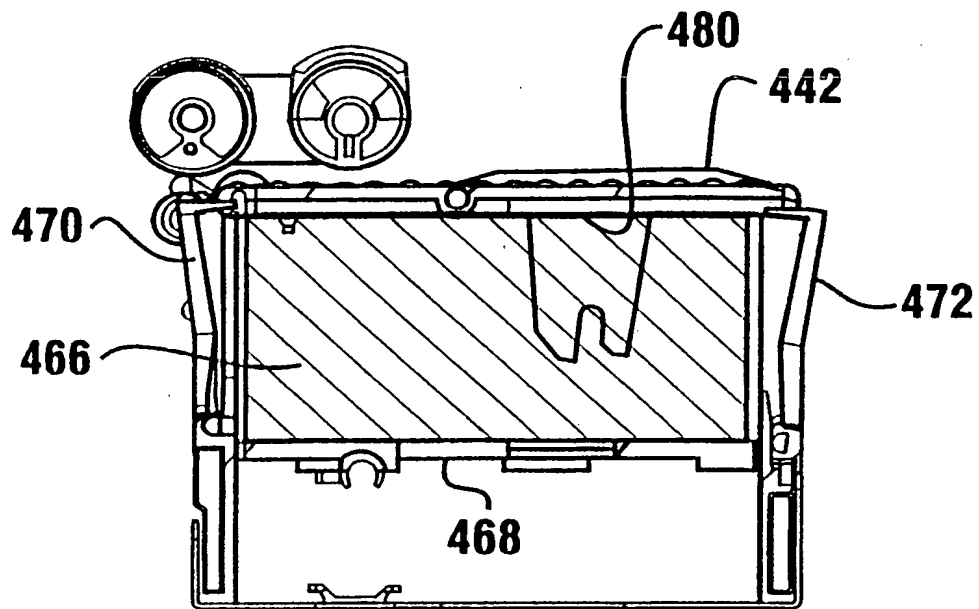


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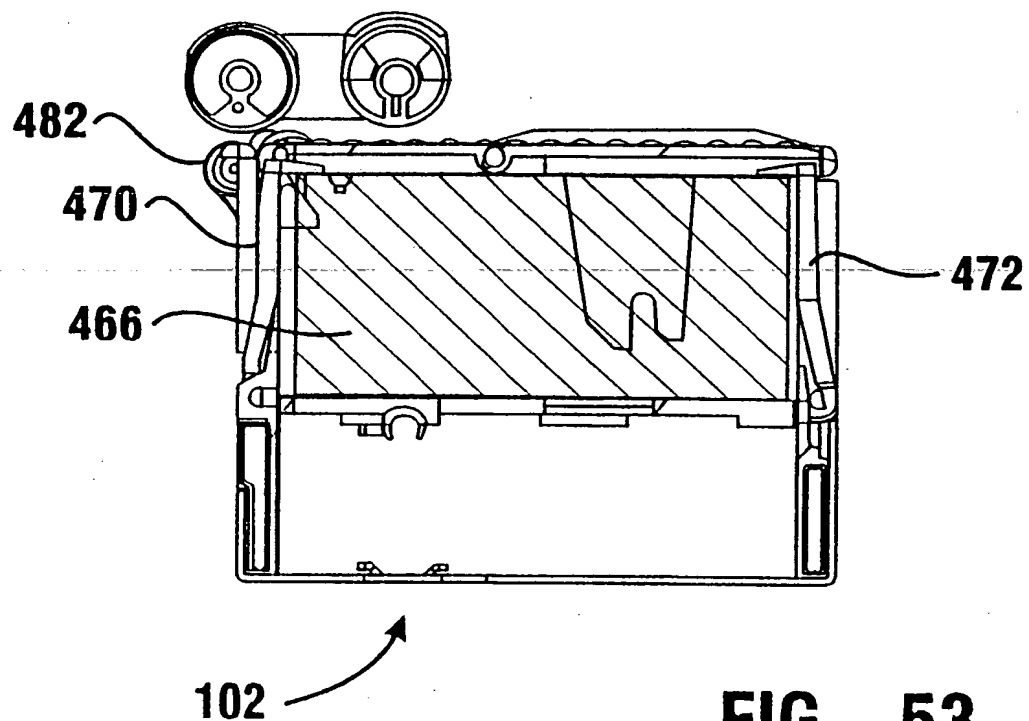
**FIG. 51**

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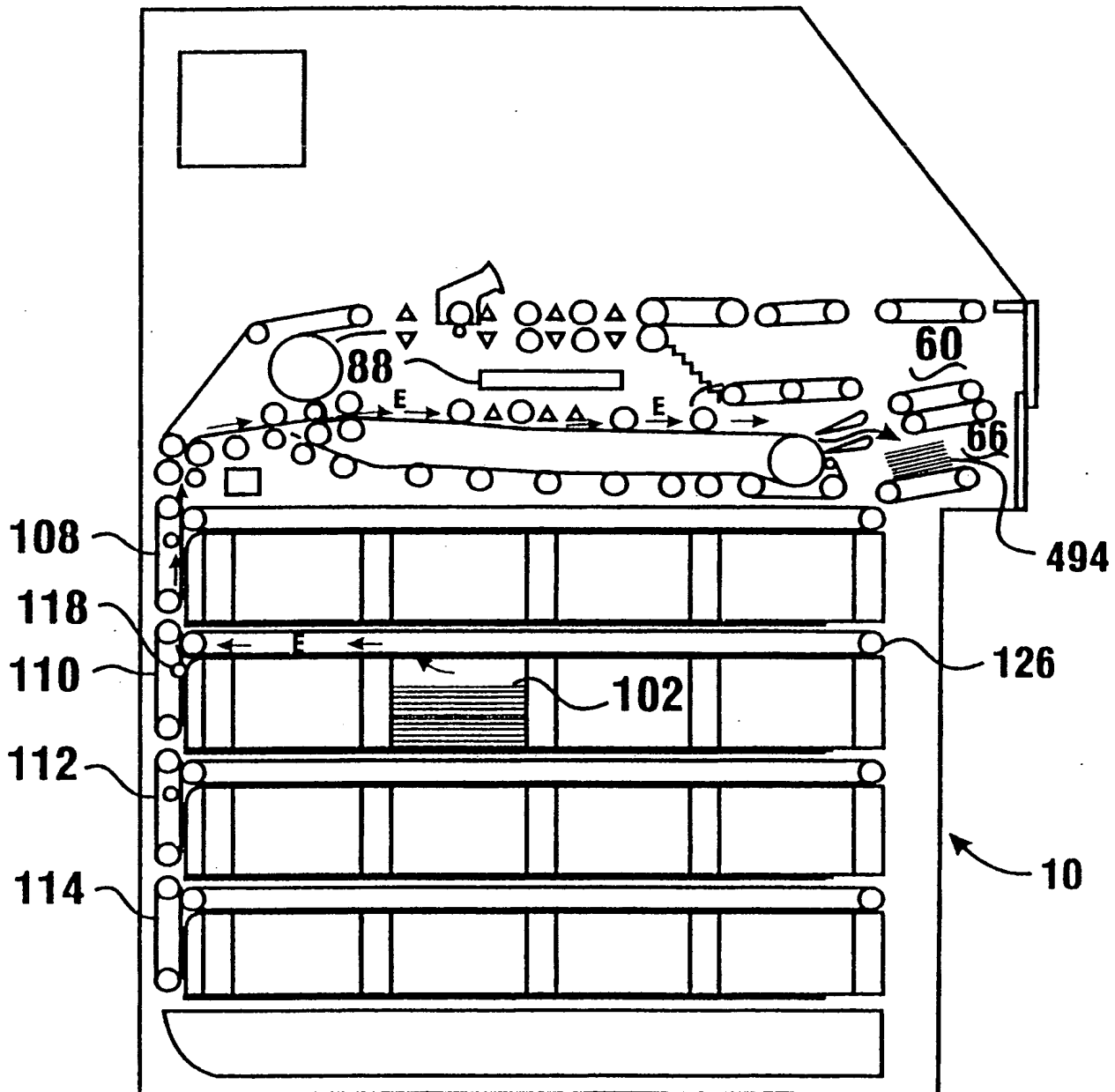


**FIG. 52**

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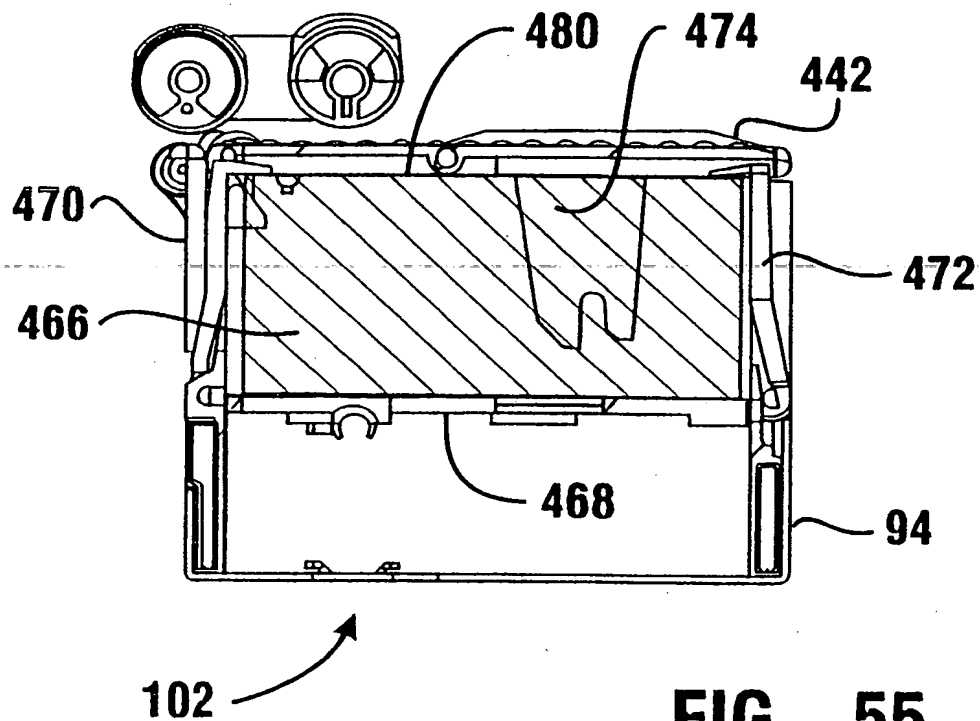


**FIG. 53**

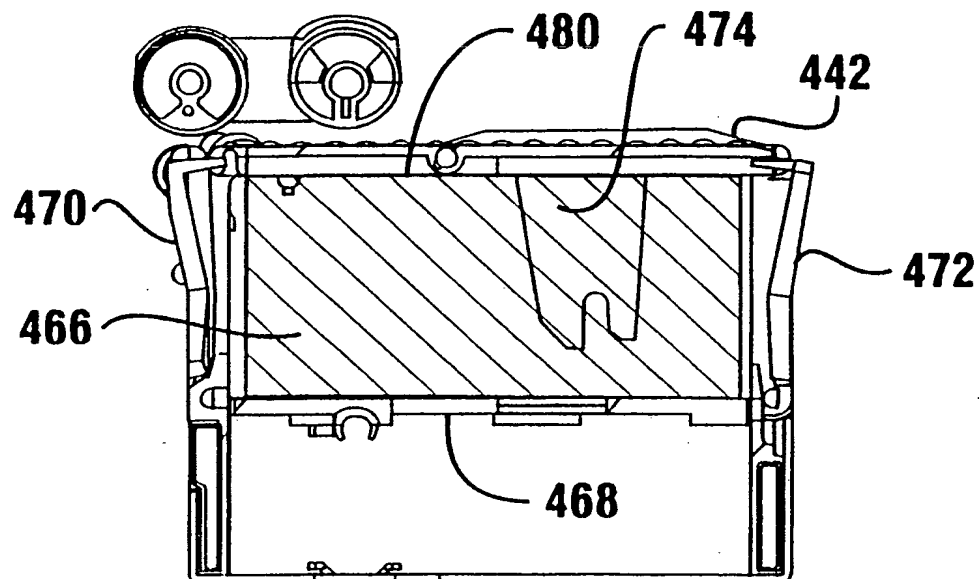


**FIG. 54**

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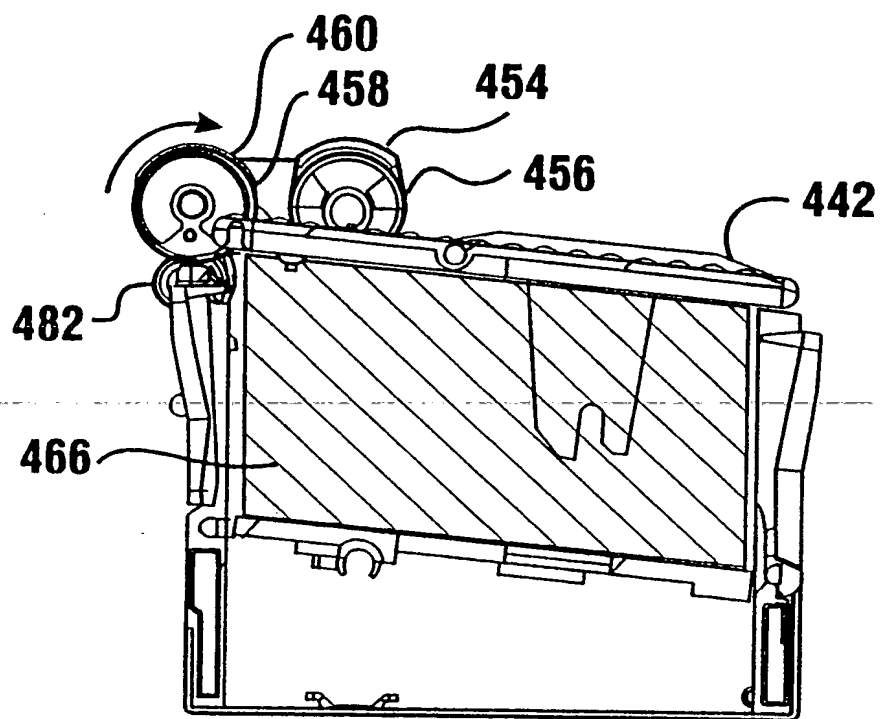


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**FIG. 56**

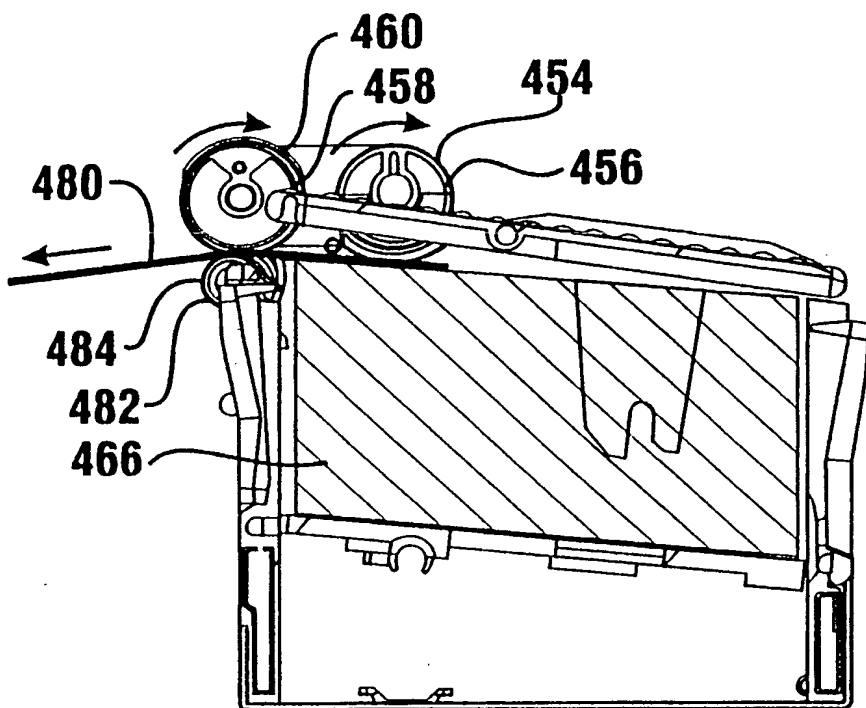
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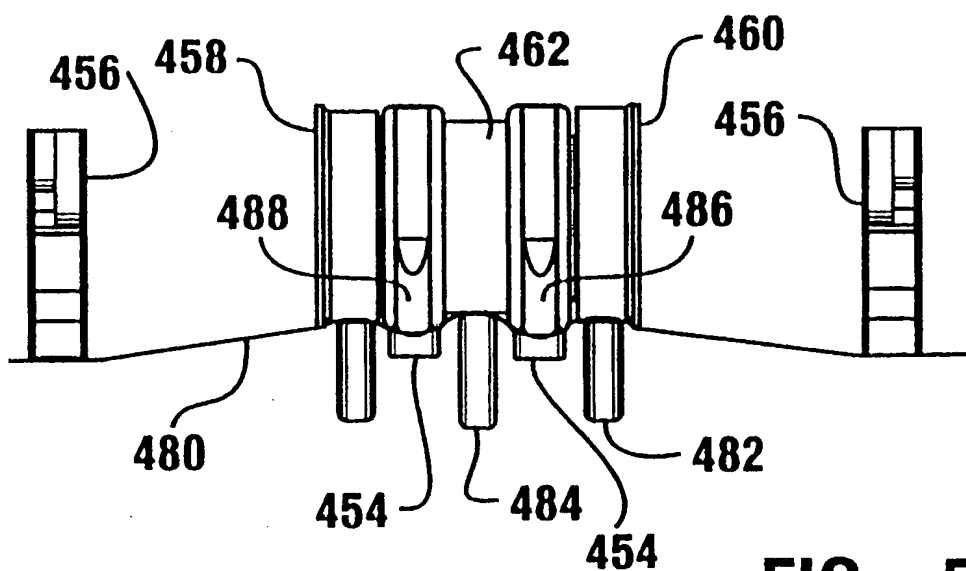
**FIG. 57**



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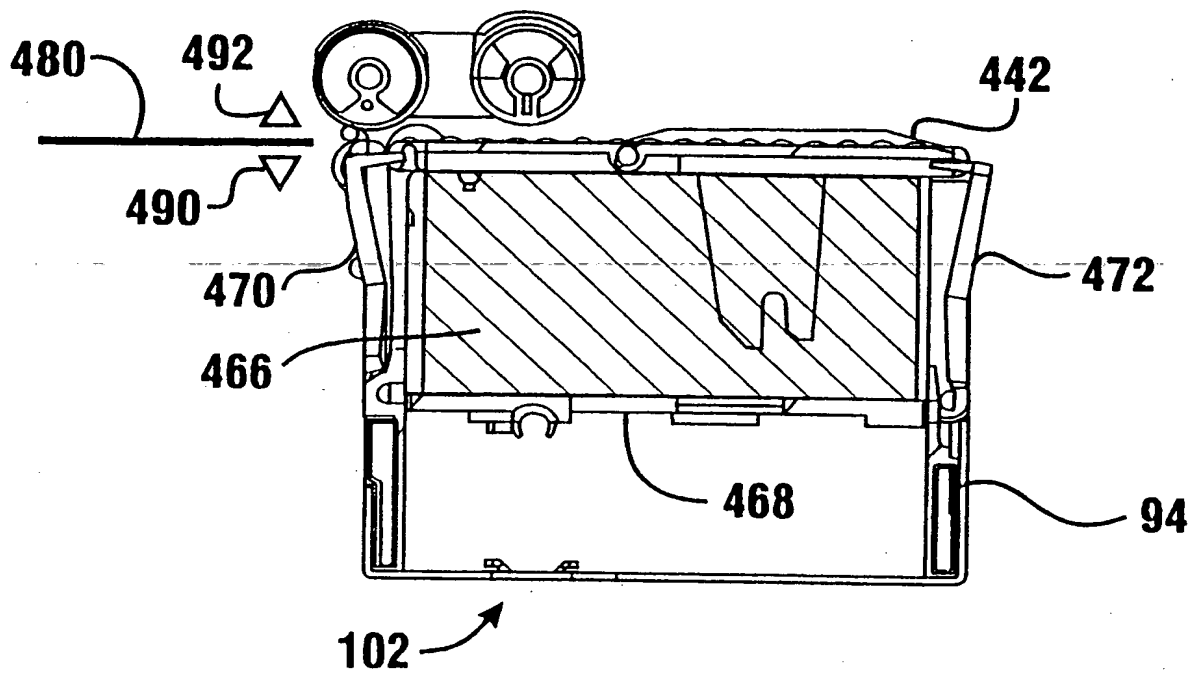


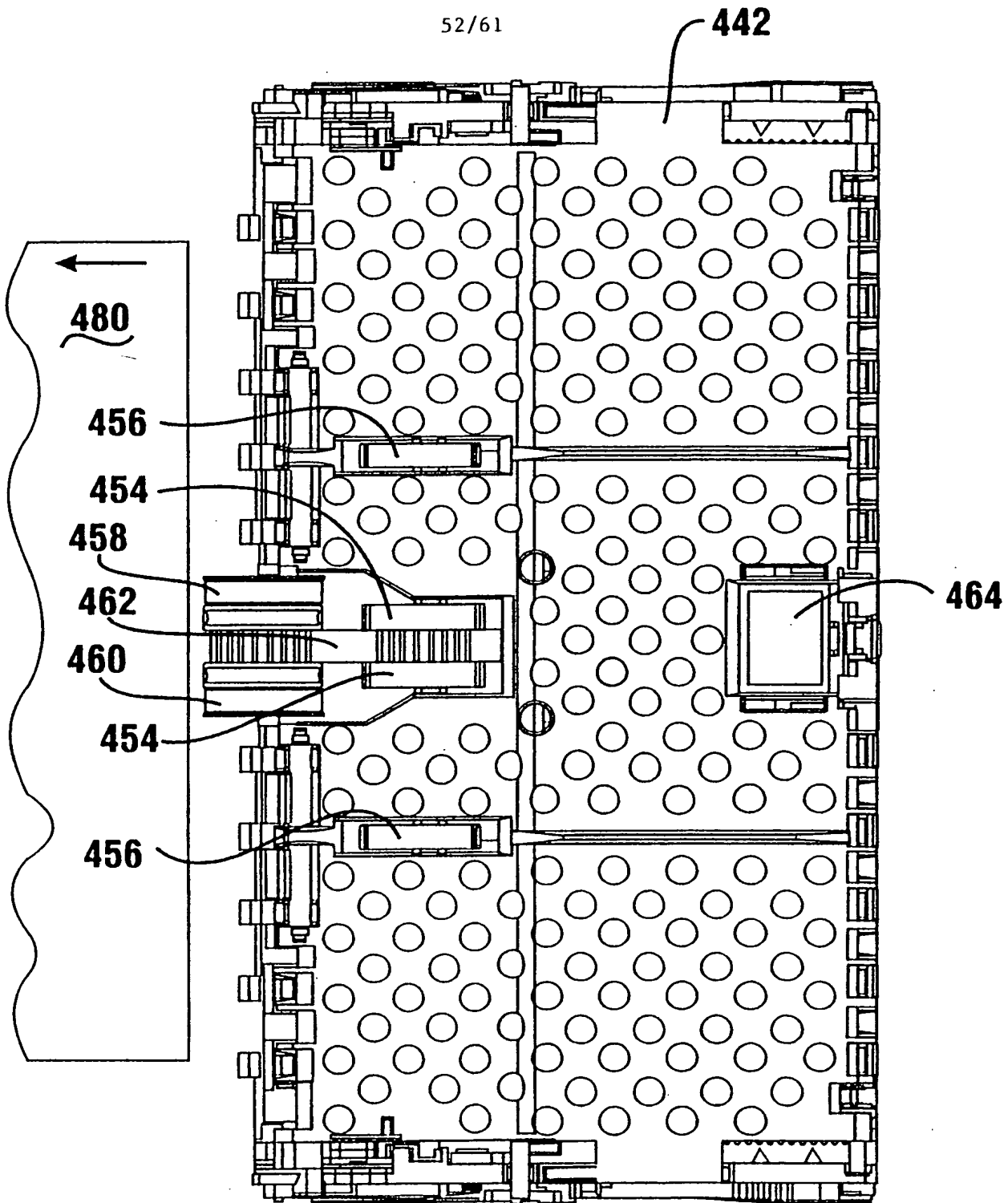
**FIG. 58**



**FIG. 59**

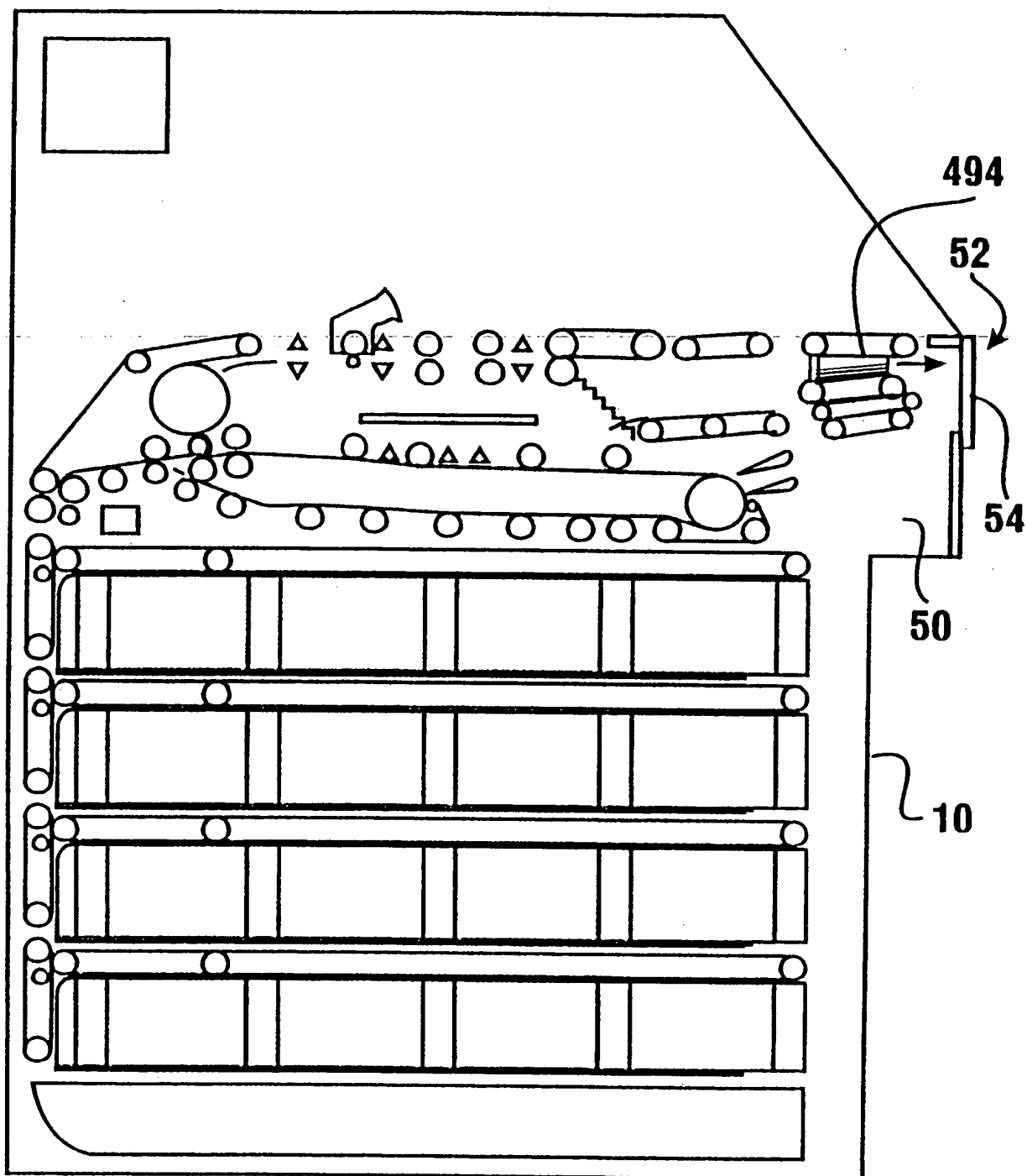
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**FIG. 60**



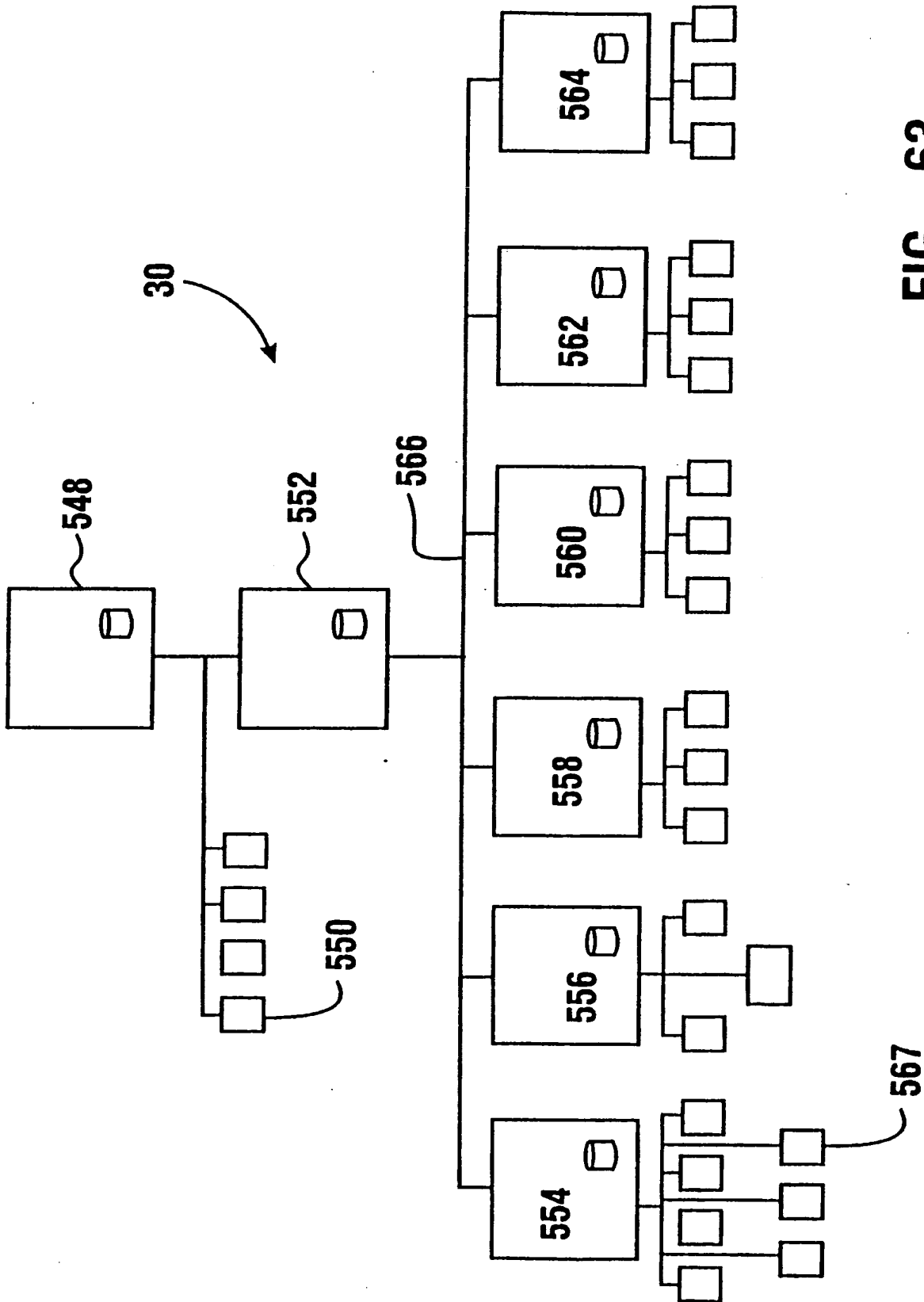
**FIG. 61**

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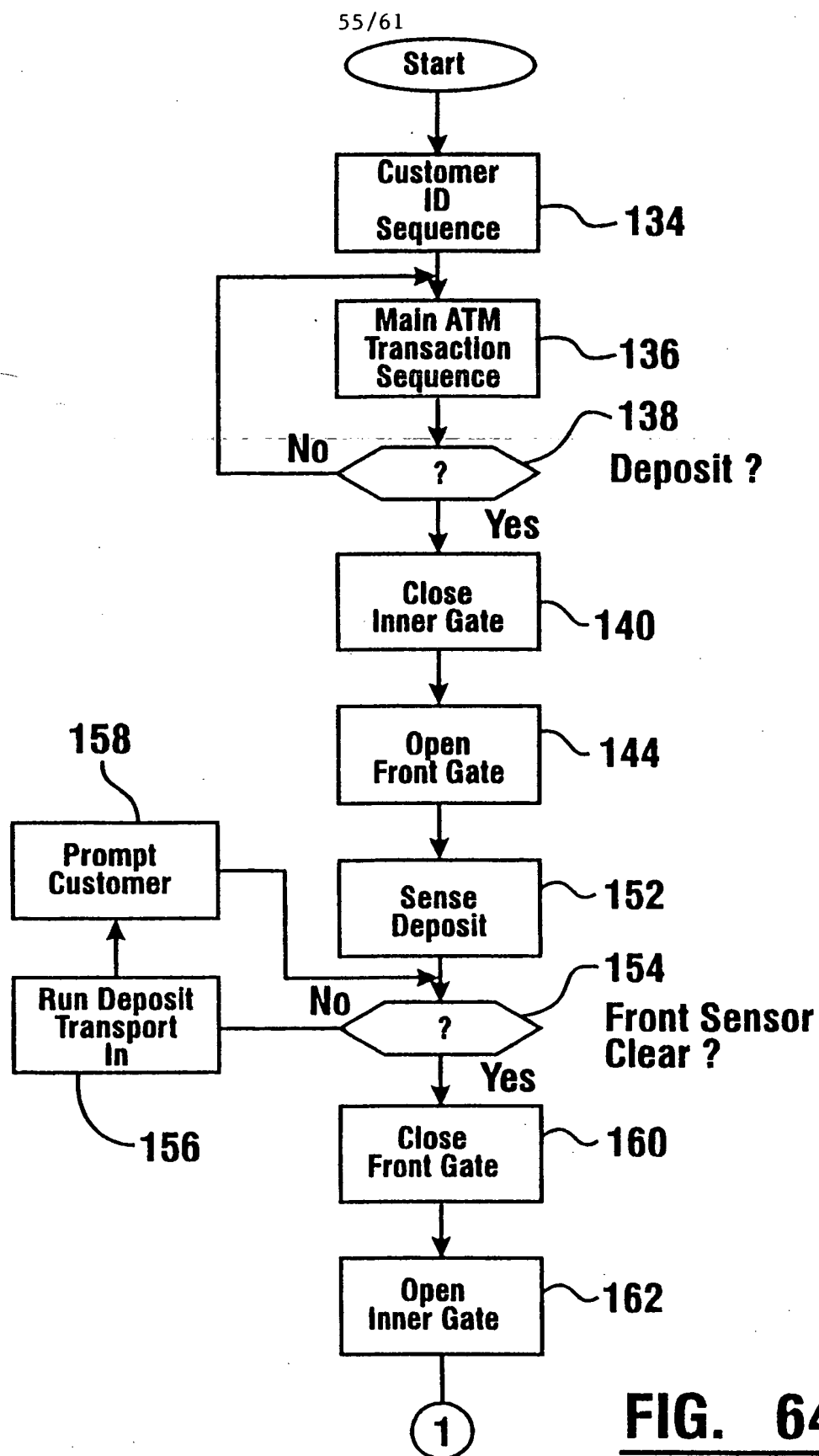


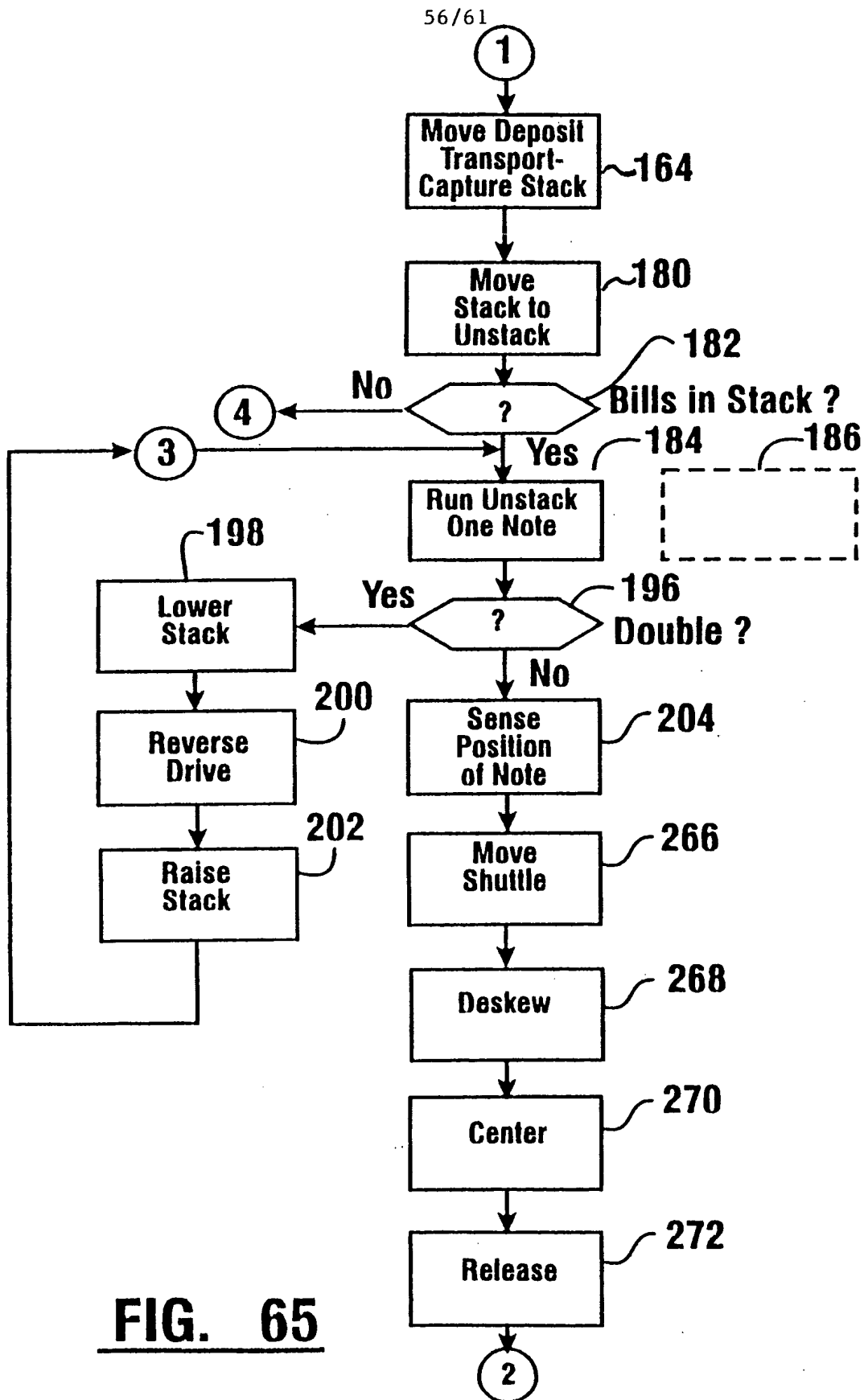
**FIG. 62**

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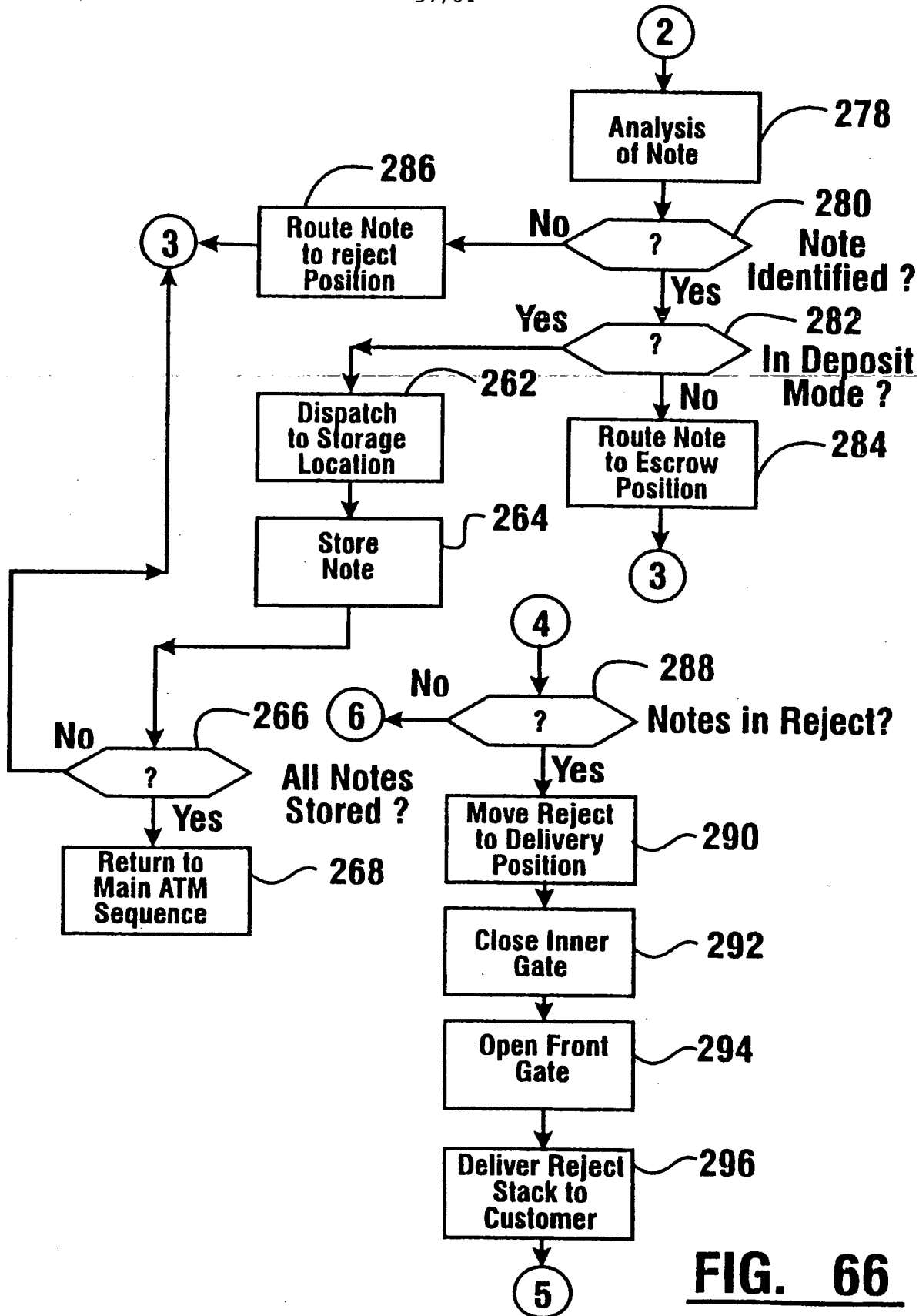


**FIG. 63**

**FIG. 64**

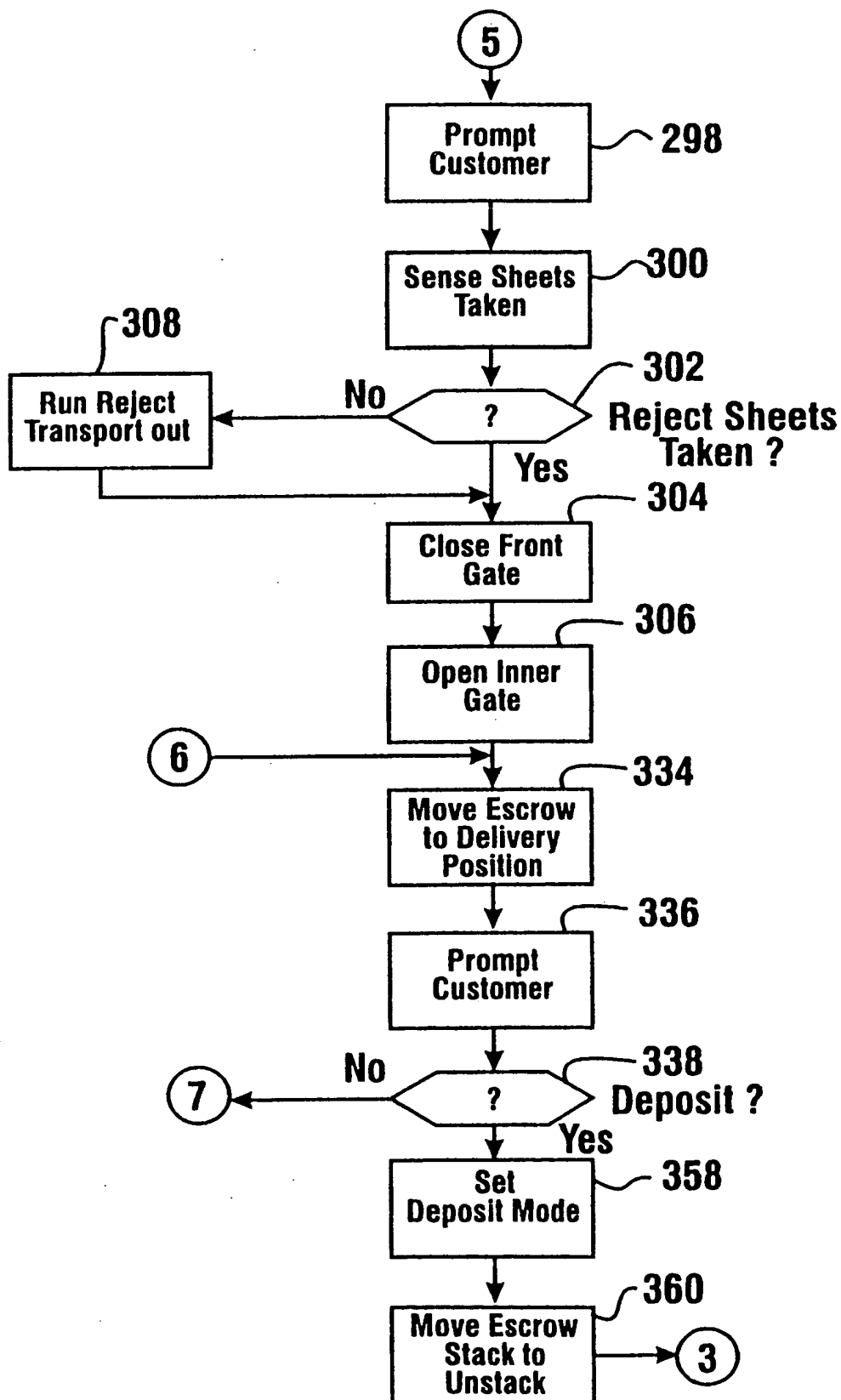


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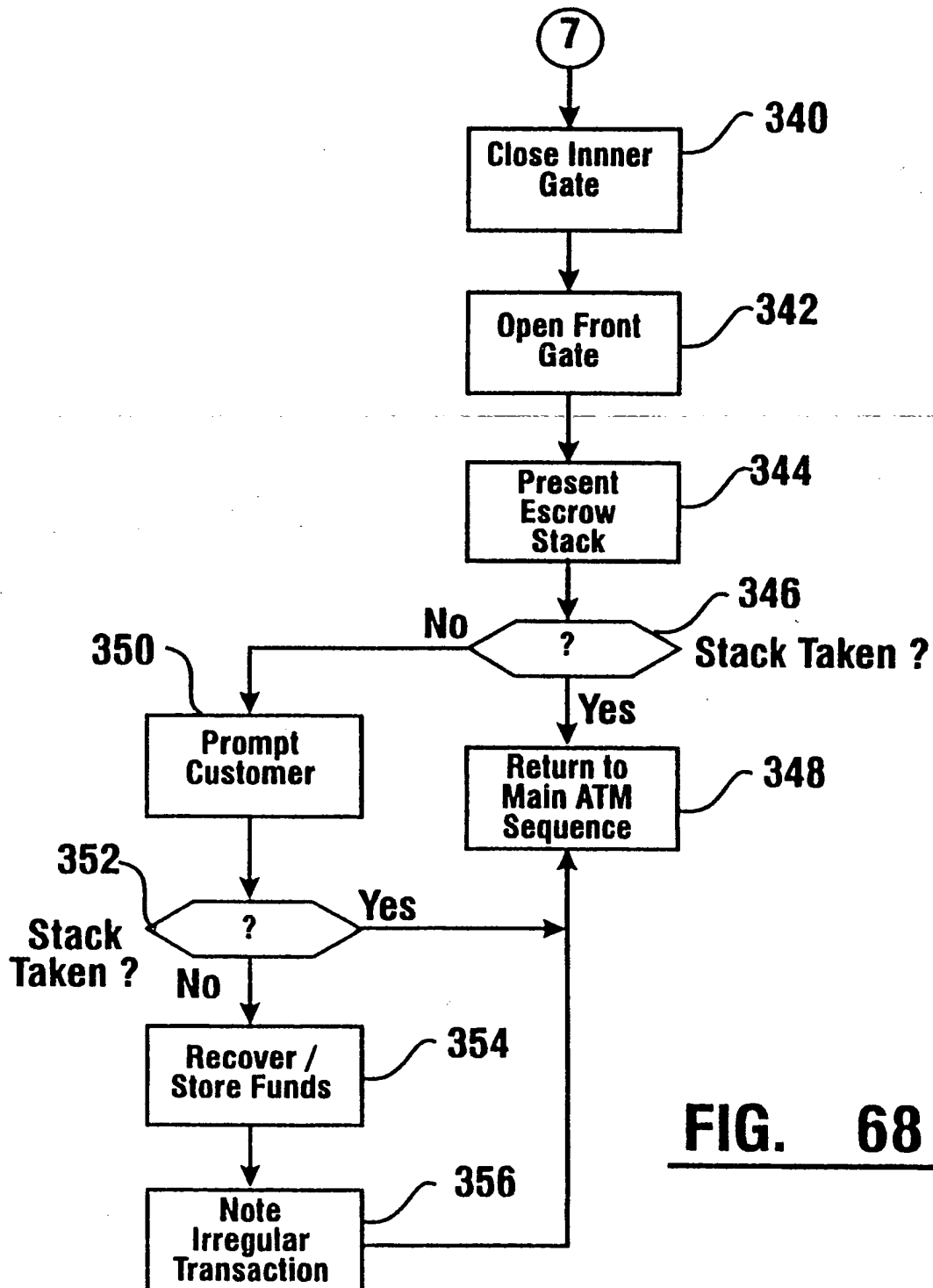
**FIG. 66**

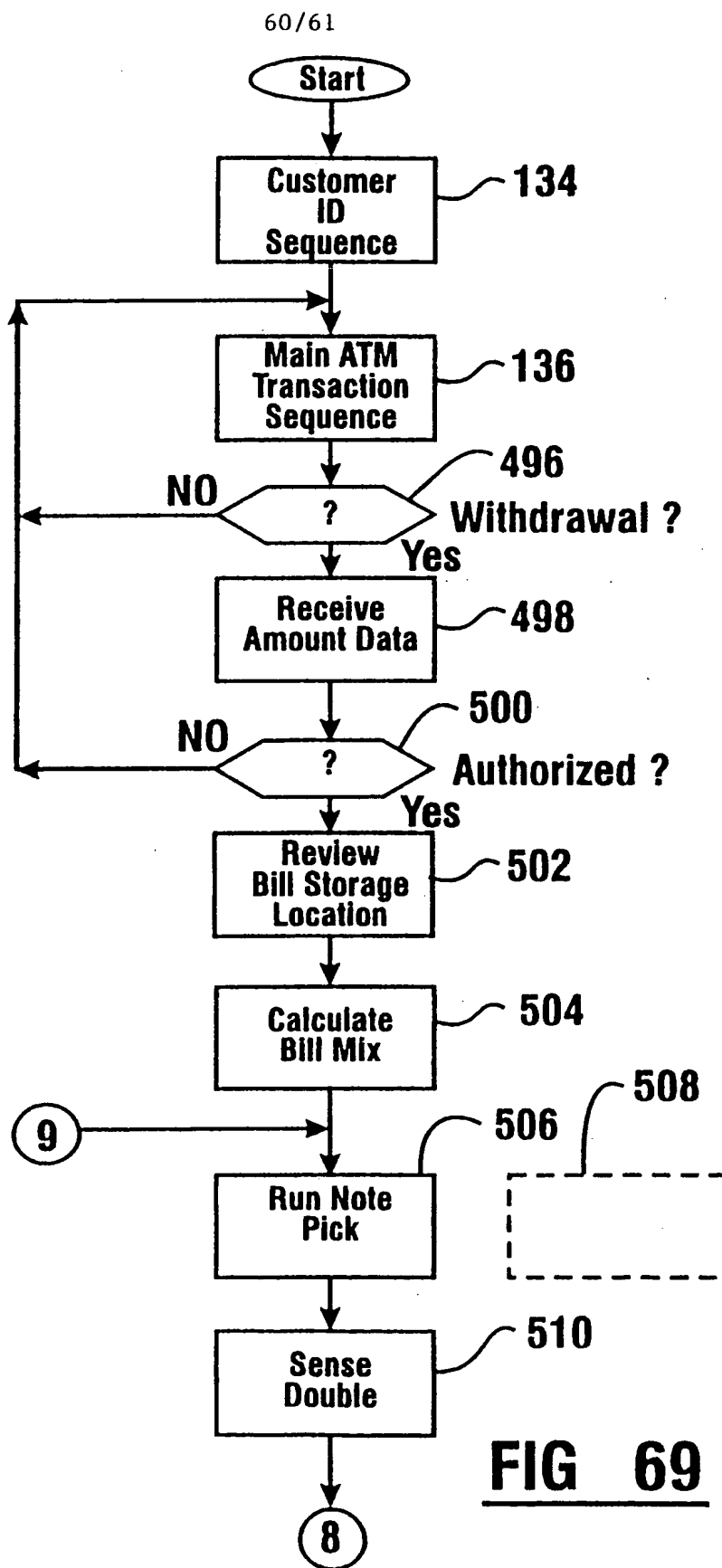


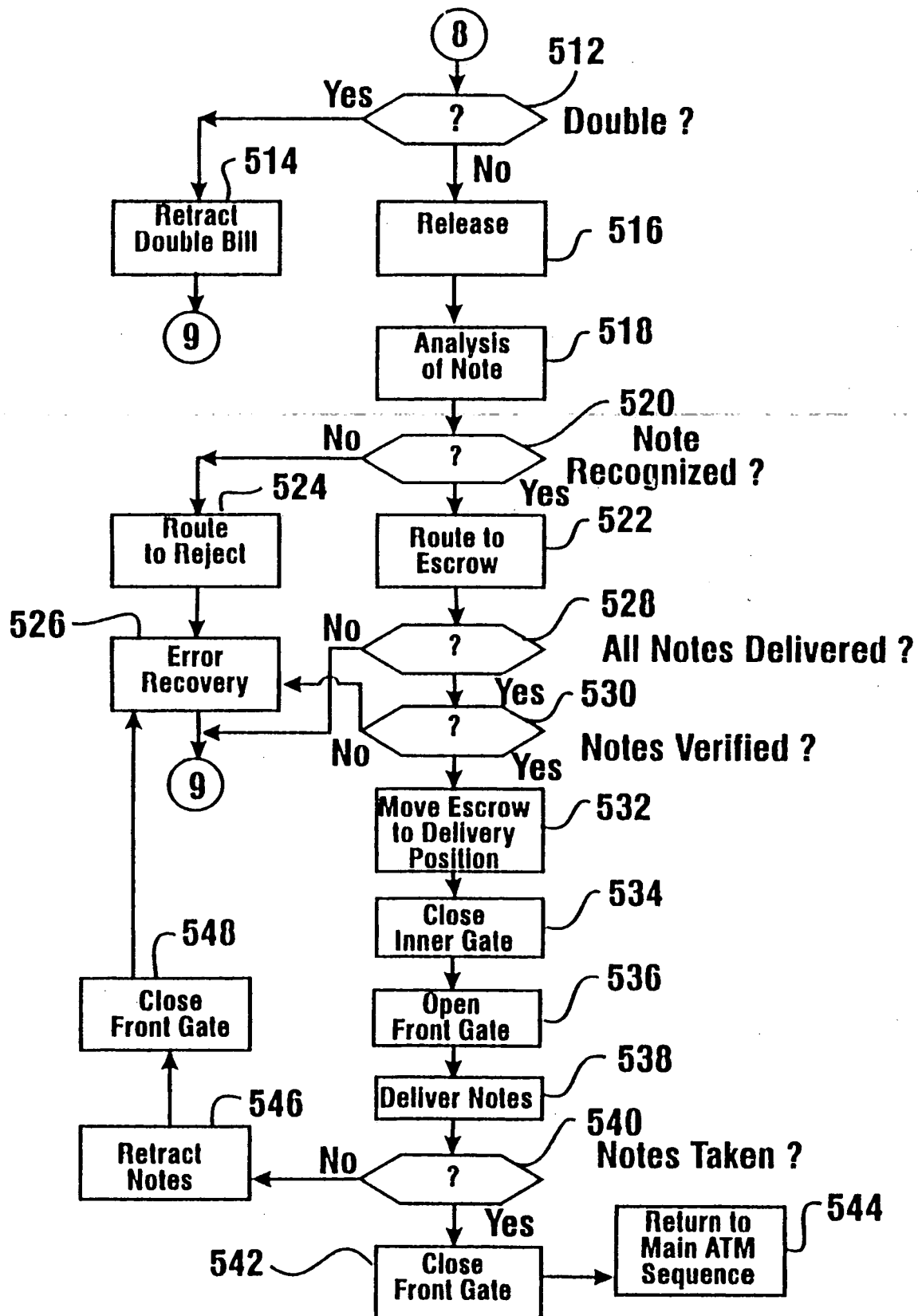
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**FIG. 67**

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**FIG. 68**



**FIG. 70**

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US98/24999

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : B65H 7/02

US CL : 271/228

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 271/225, 227, 228, 249, 250, 252

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS Search in the class/sub-classes listed above for the word "brake".

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|--|-----------------------|
| X         | US 5,443,257 (Sakamori) 22 August 1995<br>see entire document                      | Fig. 2-14b            |
| X         | US 5,681,036 (Wakahara) 28 October 1997<br>see entire document                     | Fig. 4                |
| Y         | US 5,278,624 (Kamprath et al) 11 January 1994<br>see entire document               | Fig. 1-5              |
| Y         | US 5,156,391 (Roller) 20 October 1992<br>see entire document                       | Fig. 5                |
| X         | US 5,094,442 (Kamprath et al) 10 March 1992<br>see entire document                 | Fig. 2-4              |



Further documents are listed in the continuation of Box C.



See patent family annex.

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|---|--|
| * Special categories of cited documents:  | *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention  |
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| *O* document referring to an oral disclosure, use, exhibition or other means  |  |
| *P* document published prior to the international filing date but later than the priority date claimed  |  |

Date of the actual completion of the international search

02 FEBRUARY 1999

Date of mailing of the international search report

12 MAR 1999

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